PRINCIPLES

OF

FORENSIC MEDICINE.


HONI SOIT QUI MAL Y PENSE
SANCTE ET SAPIENTER.

Mackenzie
G. I. Hospital 1866

PRINCIPLES

OF

FORENSIC MEDICINE.

BY

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PREFACE

TO THE

SECOND EDITION.

The original motive of the Author in undertaking this work was to furnish the members of his class with a system of Forensic Medicine, in which the several subjects should be arranged in the same order, and treated in the same way, as in his lectures.

This object has been kept in view in preparing the second edition for the press.

The no less important object of condensation has been attained by the abbreviation or omission of the greater number of the illustrative cases quoted in the first edition, and of some of the tables, on which much labour had been expended. The references have also been curtailed, and authors' names have been occasionally substituted for a more exact reference to their works.

The space thus gained has allowed of the introduction into this edition of several new subjects, and of a considerable

number of illustrative woodcuts, by which, it is believed, the value of the work has been much enhanced.

In introducing this new feature, the author has merely given greater development to a practice now becoming common, of illustrating medico-legal papers, and especially those on Toxicology, by wood-cuts. A page of engravings illustrative of chemical apparatus has always formed a part of Dr. Christison's work on Poisons; wood engravings are very largely used in the works on Materia Medica of Pereira and Royle; and Casper's 'Handbuch der Gerichtlichen Medicin' has an atlas of coloured prints.

The wood engravings, with the exception of those which show the appearance of the sublimates of arsenic, have been done expressly for this work; and the greater number of them are not to be met with in any shape elsewhere. They were drawn and engraved under the author's direction, chiefly from coloured drawings, preparations, and microscopic specimens in his own possession. The anatomical and pathological subjects, some of the crystals, some of the roots and most of the seeds, were drawn by Dr. Westmacott, the remainder by Mr. Hart, by whom all the engravings were executed.

As a general rule the more important subjects, such as Infanticide and Unsoundness of Mind in the first part, and Poisoning by Arsenic, Opium, and Strychnia in the third part, are the most fully treated and most largely illustrated; but the space devoted to each subject has been determined

less by its importance than by the length of the descriptions and discussions necessary to render it intelligible. It may be well to add that, while the entire work has been revised, and most parts of it condensed, many portions of it have been wholly rewritten.

It is in the third part of the work, or that which treats of Toxicology, that the largest additions and alterations have been made; so that the 165 pages devoted to this subject in the first edition have been extended to 237 in the present one. It is in this part, too, that the wood engravings will be found most numerous.

In treating this important group of subjects, an attempt has been made to render the tests for the poisons more easy of comprehension, and to impress them more effectually on the memory, by distinguishing between the *properties* of the several poisons and their *tests*, and by arranging the tests, as much as possible, in the order in which they would be applied, on the supposition that the substance submitted to analysis was unknown, the most characteristic reactions being added. Some of the properties and tests of the alkaloids and other active principles of the animal and vegetable kingdoms are stated as results of an inquiry still in progress. The portion of the work relating to the properties and tests of arsenic and arsenious acid has been remodelled in consequence of the unexpected discovery of the globular form of metallic arsenic, as deposited from its vapour. In the case of some of the more important poisons, the value of individual

symptoms, and the duration of the poisoning, have been deduced from an extensive and careful analysis of cases.

In the preface to the first edition the author had to acknowledge his obligations, in a special manner, to Beck's learned and elaborate Elements of Medical Jurisprudence; to Ray's Medical Jurisprudence of Insanity; to Dr. Gavin's work on Feigned Diseases; to the Elements of Medical Jurisprudence of Dr. A. Taylor; to Watson's Medico-legal Treatise on Homicide; and to the standard work on Poisons of Dr. Christison; as well as to several foreign monographs and systematic works.

To this list must be added, as works of constant and necessary reference, the learned treatises on Medical Jurisprudence and on Poisons, as well as the valuable toxicological Essays of Dr. Taylor, the Elements of Materia Medica of Dr. Pereira, and the Elements of Chemistry of Dr. Miller. The author has also much pleasure in recording his obligations to his friend Dr. John Harley, Medical Tutor of King's College, for his assistance in revising the press, as well as for his faithful drawings of some microscopic objects, and his useful and valuable suggestions.

26 *Gordon Street*,
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INTRODUCTION.

THE state avails itself of the knowledge, experience, and skill of the medical man for three distinct purposes:—1. For the care and treatment of soldiers and sailors, prisoners, convicts, paupers, and lunatics, and other classes of persons for whose safety governments make themselves responsible; 2. As officers of health; and 3. As skilled witnesses in courts of law.

The duties which the medical man is called upon to perform in the first of these three capacities do not differ materially from those which devolve upon him in the ordinary practice of his profession, except that he is expected to give at least as much attention to the prevention as to the cure of disease, and to add to his medical and surgical skill a fair share of administrative talent.

But as officers of health, and as witnesses in courts of law, medical men are required to perform important and responsible duties for which the ordinary practice of their profession affords no adequate preparation, medical education, till of late years, no proper training, and medical literature no sufficient guidance.

A consciousness of the distinctness, importance, and difficulty of the duties required of the medical man in these two capacities led at length to the establishment of a new and distinct science, taught in separate courses of lectures, treated of in separate works, and engaging the attention of many distinguished men more or less completely separated and set apart for the practice of the corresponding art.

This new science and art was either made to embrace the whole of the duties which the medical man may be called upon to perform on behalf of the state, in which case it received the name of Political Medicine, or State-Medicine; or it was divided into two sciences, the one under the title of Hygiène or Public Health, the other known indifferently as Forensic Medicine, Juridical Medicine, Legal Medicine, or Medical Jurisprudence.

As the term FORENSIC MEDICINE expresses at least as clearly as any of the other terms the application of medical knowledge to legal purposes, it is employed in the title of this work. It is scarcely necessary to add that the term *medico-legal* is in common use, as in the phrases "medico-legal knowledge," "medico-legal experience," "medico-legal skill."

The history of the science of Forensic Medicine resembles closely that of most other sciences. Necessity or convenience first gives birth to an art practised by individuals more or less skilful without any guidance from general principles; the importance of the art, and the responsibility attached to the practice of it, soon create a demand for instruction, oral and written, which instruction gradually assumes a systematic form; and that which was so lately an art is universally recognized as a science. Thus the science of astronomy sprang from a rude art of navigation, and the science of medicine from an empirical art of healing. The science of Forensic Medicine, in like manner, took its rise in the necessity of bringing medical knowledge to bear on legal inquiries relating to personal injuries or loss of life; the medical witness being at first without guide or instruction in the performance of his duty, and so continuing till a growing sense of the importance of his evidence, to society on the one hand, and to his own reputation on the other, created a demand for instruction which could not fail of being supplied. Cases were accordingly collected, arranged, and commented upon, illustrative facts were sought after, special experiments were devised and performed, till at length the medical witness received in books and lectures the same distinct instruction as the physician or surgeon at the bed-side had already derived from written or oral teaching in the theory and practice of medicine, or of surgery.

But the importance of medical testimony received an earlier recognition from some of the continental governments than from the public or the medical profession; for the appearance of the first medico-legal treatise (1597) was anticipated by nearly a century by the earliest state recognition (1507) of the necessity of medical evidence, and was followed within a few years by the appointment of medical men for the performance of medico-legal duties.*

The history of Forensic Medicine as a science in England is of comparatively recent date. It cannot be carried further back than the publication, in 1788, of Dr. Samuel Farr's Elements of Medical

* The following dates have an historical interest. The penal code of the Bishop of Bamberg, proclaimed 1507. A uniform penal code adopted by the Diet of Ratisbon, 1532. The *Constitutio Criminalis Carolina*, published 1553. Presentation by Henry IV. of France of letters patent to his first physician, empowering him to appoint two surgeons in every city and large town to examine and report upon wounded or murdered persons, 1603. Publication at Frankfort of the Methodus Testificandi of Condronchus, 1597, and of the works of Fortunatus Fidelis and Paul Zacchias in 1598 and 1621. First course of lectures on Forensic Medicine given by Michaelis at Leipzig, about 1650. For a learned history of legal medicine, see Traill's Outlines of Medical Jurisprudence.

Jurisprudence; and the science was first taught in lectures at the University of Edinburgh, in 1801, by Dr. Duncan, sen., the first professorship having been conferred by government on his son in 1803. Since that date the science has made great and rapid progress; its importance is fully recognized by most of the examining bodies; it is taught in all our medical schools; its principles are being constantly applied in our courts of law; and England is contributing her fair share of practical observation and original research towards its extension and improvement.

The application of the principles of the science to actual practice, or, in other words, the practice of Forensic Medicine as an art, devolves, for the most part, on the great body of medical practitioners. It is only in comparatively rare instances that those who have devoted special attention to the entire subject, or to important constituent parts of it, such as Toxicology, or who have attained to eminence in special branches of medical practice, such as midwifery and the treatment of the insane, are summoned to give evidence in our courts of law.

There are many reasons why the medical man should approach the performance of this class of duties with apprehension. He is conscious of the importance which attaches to his evidence; he is wanting in that confidence which a more frequent appearance in the character of a witness would impart; he is painfully alive to the unstable foundation upon which many medical opinions rest; he knows that it is not easy in practice to observe the rules of evidence with which in theory he may have made himself acquainted; and, above all, he shrinks from that publicity which attends all our legal proceedings, and from the unreasonable license allowed to counsel engaged not to discover truth but to achieve a victory for a client. Sympathizing in these reasonable apprehensions of the medical witness, some medical writers of eminence and most authors on Forensic Medicine have endeavoured to prepare him for the performance of his duties by setting forth the precautions he should observe both prior to and during his attendance in court. Information respecting the best mode of conducting preliminary medico-legal inquiries is generally to be found under the heads of "Post-mortem inspection," "General evidence of poisoning," "Unsoundness of mind," or other subject to which the inquiry specially refers: the precautions to be observed, when he makes his appearance in the witness-box, are commonly treated of in a distinct Chapter under the title of MEDICAL EVIDENCE. This distinction is observed in these pages.

Before proceeding to treat of the duties of the medical witness, it may be well to give some idea of the number of cases occurring year by year in England and Wales of a class to give rise to medico-legal inquiries. Taking the year 1856 as the year concerning which we have the most recent exact information, the Nineteenth Annual Report of the Registrar-General records the following figures:—

Sudden deaths (causes unascertained) . .	3,474
Intemperance, privation, neglect, and cold . .	1,128
Poison	432
External violence	13,352
Malformations, premature birth and debility, and atrophy	32,709
Total	51,095

The mixed class of deaths by external violence comprises 6,438 deaths by fractures and contusions, wounds, and other violence; 2,919 by burns and scalds; 2,681 by drowning (exclusive of deaths at sea); and 1,314 by hanging and suffocation.

The number of inquests to which these premature, sudden, and violent deaths occurring in 1856 gave rise, was 21,801: and as the number of qualified practitioners in England and Wales falls far short of this number, it follows that, if the duty of attending at inquests were distributed equally, each member of the profession would attend at least one inquest every year.

The committals for trial arising out of these 21,801 inquests amounted to 476, of which 205 were for murder, and 271 for manslaughter; and of this number 265 took their trial. In 1314 instances the death was returned as suicidal.

The total number of cases requiring medical evidence in our higher courts of law may be judged of approximatively from the printed returns of commitments for trial for offences against the person. In the year 1854 these commitments amounted to 1,849, and comprised 76 commitments for murder and attempts to murder attended with dangerous bodily injury; various attempts to maim and injure, 159; assaults, and inflicting bodily harm, 276; manslaughter, 231; attempts to procure abortion, 5; concealment of birth, 61; rape, assaults with intent, &c., 268; unnatural offences, and assault with intent, 107. If we add 15 other cases of injury to the person not comprised in the printed returns under the head of "Offences against the Person," we have a total of nearly 1,200 cases on which it is highly probable that the evidence of medical men was required. If we add to these cases nearly 22,000 inquests, the civil cases in which skilled medical evidence is required, and proceedings in respect of lunatics, the occasions on which medical men are summoned to the service of the state will appear very considerable—certainly numerous enough, and important enough in themselves to justify all the attempts which have been made to construct a science of Forensic Medicine, to teach it systematically in books and lectures, and to draw up a code of instructions for the guidance of the medical witness in the performance of his duties.

MEDICAL EVIDENCE.

The duties which the medical man may be required to perform when summoned as a witness are twofold. He may have to *state* facts, and he may have to *interpret* them ; in other words, he may be, in the language of jurisprudence, both a *common* witness and a *skilled* witness. In some cases he is a *common* witness, in others a *skilled* witness; and in others, again (and these are the majority of cases), he acts in both capacities.

As a *common* witness, his duty is to state facts ; as a *skilled* witness, to express his opinions. If he is examined as to facts which he has himself witnessed, he is also questioned as to his interpretation of them, and then he performs the double duty of a *common* and a *skilled* witness; but if summoned to state his opinion of the bearing and value of facts deposed to by others, he acts the part merely of a *skilled* witness.

This distinction, between the duties of a common witness and of a skilled witness, has not always been recognized; and some medical men have fallen into the error of supposing that they were not required to express opinions, but merely to state facts. The law on this point is, however, quite plain. "The general rule is, that a witness must not be examined as to his opinion, for his testimony must be confined to evidence of facts. But in questions of skill and judgment, men of science or experience are allowed to give evidence of their opinion." "In criminal cases, the opinions of medical men of science are very frequently employed as evidence. A physician who has not seen the patient, may, after hearing the evidence of others, be called to prove, on his oath, the general effect of the disease described by them, and its probable consequences in the particular case. So in prosecutions for murder medical men have constantly been allowed to state their opinion, whether the wounds described by witnesses were likely to be the cause of death."*

In stating facts, and in drawing inferences from them, or from the evidence of other witnesses, there are certain precautions which the witness ought to observe, and certain legal requirements of which he should not be ignorant.

In the first place, he should approach the performance of his duties in a proper frame of mind. He should "use his best endeavours that his mind be clear and collected, unawed by fear, and uninfluenced by favour or enmity." (Percival.) The witness will find it difficult to maintain this impartial frame of mind when the crime alleged is one of unusual enormity, when popular feeling runs high either for or against an accused person, or in times of public agitation, when a popular movement may seem to be endangered by evidence given in favour of an individual, or when he is engaged distinctly for the prosecution or for the defence. In this latter case, he must not deem himself free

* Burn's Justice, Title, Evidence.

from the risk of partiality, even though, after hearing all the facts upon which his opinion must be formed, and making proper personal inquiries, he feels that he can conscientiously give his evidence in favour of the party for whom he is retained.

The medical witness requires to be specially cautioned against expressing an opinion on the general merits of the case under inquiry, thus offending against an admitted principle of English law, that "when scientific men are called as witnesses, they are not entitled to give their opinion as to the *merits of the case*, but only as to the *facts proved on the trial*." Against this rule many eminent members of the medical profession have offended, and been reprimanded accordingly.

A special caution is also required against a feeling of misplaced humanity, or an equally misplaced condemnation of the law on the score of undue severity. It was under the influence of both these feelings that the late Mr. Abernethy,* when speaking of the necessity for examining the lungs in all cases of suspected infanticide, gave expression to the unsound sentiment—"It is your duty, I think, to try to weaken the effect of your testimony on this point." This was a great error; for if there is one thing more essential for the medical witness to remember than another, it is, that he has nothing whatever to do with the consequences to which his opinions may lead, provided always that they are the result of cautious inquiry and due reflection. "The dread of innocent blood being brought upon us by explicit and honest testimony, is one of those superstitions which the nurse has taught, and which a liberal education ought to purge from the mind; and if, in the performance of our duty, innocence should unfortunately be involved in the punishment of guilt, we shall assuredly stand acquitted before God and our own consciences." (Percival.)

The medical witness approaching his duties with a mind thus free from bias, requires some instruction as to the mode in which his evidence should be given.

Bearing in mind the distinction already laid down between the duties of a common witness and of a skilled witness, he should be cautious not to obtrude his opinions when facts only are required of him, nor dogmatically to assert as facts things which are merely matters of opinion. He should answer the questions put to him, whether by the counsel, the court, or the jury, clearly and concisely, and if none of these elicit the whole truth, it is his duty to supply what is wanting. Such additions are always gratefully received by the court.

The statements which the witness has to make, and the opinions he expresses, should be couched in the plainest and simplest language; and he should avoid as much as possible all technical terms, and when it is absolutely necessary to use them, explain them in the clearest and simplest way. It is scarcely necessary to add, that he should carefully avoid all figurative and metaphorical expressions.

* Lectures, 'Lancet,' vol. xii. p. 227.

The medical witness ought also to understand that he is not allowed to quote authorities in support of his opinions. The rejection of such appeals to authority has been unjustly stigmatized as "a compromise of the rights and dignity of the profession,"* and the rule of exclusion has not always been rigidly acted on. There can be no doubt, however, that the common usage of our courts of law is to disallow these appeals to authority.

This exclusion of all appeals to authority is not attended with any bad effect, inasmuch as the medical witness is supposed to have made himself master of the opinions of the most eminent writers on the subject-matter of his evidence, and to have employed these opinions as the basis of his own inquiries and experience, so as to embody in his own evidence the opinions of the leading authorities of his profession.

But though the medical witness is precluded from citing authorities, he may be made the medium of bringing them into play; for he may be asked whether A or B is an esteemed authority with his profession, and whether he (the witness) coincides with some opinion expressed in his works. If the witness answers in the affirmative, he becomes the exponent of the opinion to which he has thus given his assent.

The suggestions now made as to the mode in which the medical man ought to give his evidence will be of little use to him, unless he have previously prepared himself with care for the duty which he is about to discharge. It will contribute greatly to the right performance of this duty if he avail himself of the assistance and advice of other members of the profession, more especially of such as have devoted some attention to medico-legal inquiries. It has been recommended, too, that the medical witnesses about to be examined should first meet together and agree on the opinions which they shall express.

The foregoing observations relate chiefly to the mode in which the medical witness should give his evidence; the precautions to be taken in order that his evidence may be admissible still remain to be considered. These precautions may be treated under the heads of Notes, Confessions, and Death-bed declarations.

Notes.—When observing any facts which, at a future time, may become the subject-matter for legal inquiry, the medical man should not trust to his memory, but commit the facts to writing. This should be done, either on the spot, or as soon as possible after the transaction to which they relate. If, as in performing a post-mortem examination, it is necessary to resort to dictation, the notes of the amanuensis should be immediately examined and corrected.

These notes may afterwards be used by the witness in court to *refresh* his memory, but not to supply its place. If the facts were not committed to writing till some time after the events to which they refer, or if, having been made at the proper time, they have been entirely forgotten, the notes will be of no use to him.

Confessions.—The medical man may receive confessions of guilt

* Smith, 'Analysis of Medical Evidence,' p. 128.

from those whom he is called upon to attend professionally, and it is important that he should know under what conditions these are admissible in a court of law.

"A confession, in order to be admissible, must be free and voluntary, that is, must not be extracted by any sort of threats or violence, nor obtained by any direct or implied promises, however slight, nor by the exertion of any improper influence." The duty of the medical man with regard to confessions is, therefore, clear. If called upon to receive a confession, he must take care not to hold out any sort of inducement to make it; he must avoid suggesting matter for the confession by leading questions; he must receive what is said to him without comment, reduce it to writing as soon as possible, read it over to the person confessing, obtain his signature to it, and countersign it himself.

The medical man should also be careful to ascertain the state of bodily health and of the mind of the party making the confession. The necessity of this caution is well illustrated by cases quoted by Dr. Southwood Smith,* in which the mind was affected either by disease, or the chronic influence of hardships and exposure.

To these examples might be added other confessions of murders never committed, and self-accusations of impossible crimes, such as witchcraft.

Dying Declarations.—Dying declarations are admitted as evidence in cases of homicide, where the death of the deceased is the subject of the charge, and the circumstances of the death the subject of the declaration. They form an exception to the rule that all evidence in criminal cases must be given on oath; and they are admitted on the principle that the party being at the point of death, and without hope of recovery, is induced to speak the truth by considerations as powerful as an oath administered in a court of justice. It follows, therefore, that a declaration, though proved to have been made by a person in a dying state, is not admissible unless it also appear that the deceased apprehended himself to be in such a state as would oblige him soon to answer before his Maker for the truth or falsehood of his assertions. It is not necessary, however, that the deceased should *express* his apprehensions. His consciousness of approaching death may be inferred from the nature of the wound, or illness, or from other circumstances of the case. But if any hope whatever be entertained, whether spontaneously or on the suggestion of others, or even if it be inferred to exist, death-bed declarations cannot be received in evidence.

"As the declarations of a dying man are admitted, on a supposition that in his awful situation, on the confines of a future world, he had no motives to misrepresent, but, on the contrary, the strongest motives to speak without disguise and without malice, it necessarily follows, that the party against whom they are produced as evidence may enter into the particulars of his state of mind and of his behaviour in his last moments, or may be allowed to show that the deceased was not

* Lectures on Forensic Medicine, 'Med. Gazette,' vol. xxi. p. 628.

of such a character as was likely to be impressed by a religious sense of his approaching dissolution."

Having thus stated the law respecting dying declarations, it will not be difficult to prescribe the course which the medical man ought to adopt when called upon to receive such declarations. As dying declarations are but confessions, made under a more solemn and binding sanction, all that has been said on the subject of confessions is applicable here. The medical man should merely receive the declaration, without putting any leading questions, but confining himself to such inquiries as may be necessary to clear up any ambiguity in the dying man's statements. He should record the very words used, and, if there be time for it, he should commit the declaration to writing, read it to the dying man, and obtain his signature to it. If the declarant's death take place so suddenly that there is no time for this, he should make a memorandum of the conversation at once, while it is fresh in his memory, and before the words used have escaped him. To this document the witness will be allowed to refer to refresh his memory when he gives his evidence. Another essential part of the medical man's duty is to ascertain the exact state of the declarant's mind, whether he is calm and collected, or otherwise, and whether he is under the influence of any particular bias, or undue feeling of resentment.

It is scarcely necessary to remark that the medical witness may be examined as to conversations which may have taken place in the presence of an accused party, with a view to ascertain his bearing and demeanour. When in attendance therefore on cases likely to become the subject of inquiry in a court of law, the medical man should be attentive to the words of speakers and the demeanour of listeners.

It ought, however, to be understood that *hearsay* is not admissible as evidence unless it form part of the *res gesta*. A medical witness, therefore, would not be allowed to cite a case of his own observing in support of his opinions if the case consisted in part, as it must needs do, of statements made by the patient, his friends, or attendants.

It still remains to state the usage of our courts of law with regard to *secrets* confided to the medical man in the course of his professional attendance. "It was solemnly decided, in the case of the Duchess of Kingston, that in a court of justice medical men *are* bound to divulge these secrets when required to do so." "If a medical man," said Lord Mansfield on that occasion, "was voluntarily to reveal these secrets, to be sure he would be guilty of a breach of honour and of great indiscretion; but to give that information which by the law of the land he is bound to do, will never be imputed to him as any indiscretion whatever."

It may be necessary to warn the medical man against taking part in duels, even though his object in being present at them is to save life, and not to destroy it. He should also understand that a witness is not obliged to give evidence which may tend to criminate himself.

The following is a summary of the principal contents of this chapter.

1. *As regards the state of the witness's mind.* He should never

consider the general merits of the case, nor allow his mind to be swayed by prejudice of any sort. He should guard most carefully against any bias in favour of or against an accused party.

2. *As to the mode of giving his evidence.* He should not be forward to state facts or express opinions which are not actually called for; but, at the same time, he should withhold no statement which is essential to the information of the jury. He should use the plainest and the simplest language, avoiding, as much as possible, technical terms, and all metaphorical expressions. He should quote no authorities, but merely state his own judgment. In cases of difficulty, he should, if practicable, provide the assistance of other medical men.

3. *Circumstances affecting the admissibility of his evidence.* In matters of importance, he should never trust to memory, but take notes; at the time if possible, but if not, as soon as may be after the facts or occurrences to which they refer. If he employs an amanuensis, he should examine and correct the notes at once. These notes may be used to *refresh* the memory, but not to supply its place. When called upon to receive a confession, he must take care to hold out no promise or threat of any sort. He must receive it without *comment*, reduce it to writing on the spot, read it over to the person making it, obtain his signature to it, and countersign it himself. In doing so, he must not omit to ascertain, to the best of his ability, the state of mind of the party making the confession. Similar rules apply to death-bed declarations. Such inquiries only should be made as are necessary to clear up any ambiguity in the dying man's statements. The very words used should be taken down; and if there is time for it, they should be read to him, and his signature obtained. If the death take place so suddenly, that there is no time for this, a memorandum of the conversation should be made while the very words used by the dying man are fresh in the memory. In this case, as in that of confessions, every endeavour should be used to ascertain the state of the declarant's mind. The witness should also be attentive to the conversations held in cases likely to become the subject of judicial inquiry, and to the demeanour of the persons present at them or taking part in them. But he should bear in mind that *Hearsay* is only admissible as evidence when it forms part of the *res gesta*.

4. The medical man should further understand that he may be required in a court of law to divulge the secrets confided to him by patients; that he may expose himself to a criminal prosecution for taking any part in duels; and that he is not obliged to give evidence which would have the effect of criminating himself.

Consult on the subject of this Chapter, Philips and Starkie on Evidence; An Analysis of Medical Evidence, by John Gordon Smith, M.D.; Amos's Lectures in the 7th Volume of the Medical Gazette; Percival's Medical Ethics; Archbold's Summary of the Law relative to Pleading and Evidence in Criminal Cases. Also Burn's Justice, by E. V. Williams, title Evidence.

FORENSIC MEDICINE.

PART I.

CHAPTER I.

PERSONAL IDENTITY. AGE. SEX.

THESE three subjects are thrown into one group, because they have a close connection with each other. Thus, the body or remains of some unknown person may be found, and it may be necessary to ascertain first the sex, then the age, and afterwards to identify the individual by means of peculiar and characteristic marks. In other instances these questions are raised separately. The three subjects are arranged in this Chapter in the order which appeared most convenient, the subject of sex occupying the last place, from its connection with the topics contained in the next Chapter.

PERSONAL IDENTITY.

Questions of Identity are of frequent occurrence in our courts of law. A child claims an inheritance: is he the person he pretends to be? A man who has been robbed is required to identify the thief; and a witness may be examined as to the identity of a party with whom he is acquainted. There is one instance, also, in which a jury may be impannelled for the sole purpose of trying the question of identity, viz., where a prisoner after conviction makes his escape and is retaken. The question of identity may also be raised as to persons found dead; and in coroners' inquests the very first step taken is to identify the body or any remains of it that may be found.

The subject of personal identity, then, divides itself into 1, *The Identity of the Living*, and 2, *The Identity of the Dead.*

1. IDENTITY OF THE LIVING.

In identifying living persons the aid of a medical man is rarely required, unless in the case of deformities or injuries, the nature or effects of which he may be called upon to explain; or where changes have been produced in the external appearance by the application of colouring ingredients to the skin or hair. But in order to give completeness to the present subject, some questions will be briefly noticed which do not require medical evidence for their solution.

In the case of parties claiming inheritance, much stress has been laid on family resemblance as a means of identification. Thus, in the celebrated Douglas case, Lord Mansfield said, "I have always considered likeness as an argument of a child's being the son of a parent. A man may survey ten thousand people before he sees two faces perfectly alike, and in an army of one hundred thousand men every one may be known from another. If there should be a likeness of feature, there may be a discriminancy of voice, a difference in the gestures, the smile, and various other things; whereas, a family likeness runs generally through all these, for in everything there is a resemblance, as of features, size, attitude, and action." This case was decided in favour of the claimant, Archibald Douglas, in consequence of his proved resemblance to Colonel Stewart, his father. The twin brother, Sholto, who died young, was proved to have equally resembled Mrs. Stewart, the mother.

On the other hand, it ought not to be forgotten that persons having no connection by relationship or descent may bear the closest resemblance to each other, as in the following remarkable example.

In the year 1772, one Mall, a barber's apprentice, was tried at the Old Bailey for robbing a Mrs. Ryan of Portland Street. The witnesses swore positively to the identity of the lad, and the whole court imagined him guilty. But he succeeded in proving his innocence by reference to the books of the court; from which it appeared that on the day and hour when the robbery was committed the lad was on his trial at the bar where he then stood for another robbery, in which he was likewise unfortunate enough to be mistaken for the person who committed it.

In this same class of cases the question of identity may resolve itself into a consideration of the change which the lapse of time, coupled with fatigue, hardship, and privations, may produce in the personal appearance of the claimant.

This question was raised in the case of Cassali, a noble Bolognese, who left his country at an early age, and was supposed to have lost his life in battle; but, after an absence of thirty years, returned and claimed his property, which his heirs had appropriated. The change in his appearance was so great that he was treated as an impostor, and thrown into prison. The judges, being in doubt, consulted Zacchias, who in his consultation mentioned several causes which might produce such a change, as age, change of climate, diet, mode of life, and disease.

Cassali had left home in the bloom of youth, had been exposed to the hardships of a military life, and if the claimant's account of himself might be believed, he had languished for years in prison. As the heirs could not prove the death of Cassali, the judges, influenced by the opinion of Zacchias, decreed that his estates should be restored to him.

The question of identity assumes a more complicated form when some person more or less closely resembling the true claimant is brought forward, or presents himself, to contest the claimant's right. The reader will find illustrations of both these frauds in the cases of Baronet and Martin Guerre, which, with that of Cassali already cited, and other leading cases from the 'Causes Célèbres,' are quoted and criticised by Foderé in the second chapter of his 'Traité de Médecine Légale.' They will also be found in an English dress in Beck's 'Medical Jurisprudence,' in the Chapter on Age and Identity.

In many cases of disputed identity the difficulty has been solved by means of peculiar personal marks, upon which the medical man has been required to state his opinion. These marks are either nævi materni, or moles, or deformities, or the scars of foregone disease or injury. Even these personal marks, however, have been found, by a strange coincidence, to be present in two individuals otherwise closely resembling each other. Thus, Joseph Parker, who was tried at New York in 1804, on a charge of bigamy, not only closely resembled one Thomas Hoag, for whom he was mistaken, in general appearance, but had in common with him a scar on the forehead, a small mark on the neck, and a lisp in his speech; but, unlike Hoag, he had no scar on his foot. That he was Joseph Parker, and not Thomas Hoag, was also proved to the satisfaction of the jury by an alibi. (Beck, Chapter on Age and Identity.)

In a Belgian case reported in one of the French Journals for 1847, a question of identity turned in some degree on the possibility of the removal of scars. The medical man, M. Vandelaer, stated that scars might be removed by time or by artificial means, and the physicians of the prisons of Valvorde and Ghent confirmed this opinion by stating that prisoners are in the habit of effacing scars by applying a salted herring to them. MM. Lebeau and Limanges, on the other hand, contended that scars could not be removed. This latter opinion is doubtless the correct one; though it must be admitted that scars grow less distinct with the lapse of time, and may also be rendered less distinct by friction or the use of stimulants. The belief that they may entirely disappear is probably founded on the very slight marks often left by very extensive wounds when they heal by what is technically called the "first intention." Thus, in the case of a maniac who had completely removed the parts of generation, the situation of the wound was marked by so faint a white line that it might be overlooked by a casual observer; and a severe flogging which has left the back quite raw at the time is traceable after an interval of some years only by

very fine white lines upon the back and sides, and, where the knots had fallen, by little round pits resembling small white circles neatly cut out by a punch. In one case in which the author was consulted, the entire absence of both kinds of mark enabled him to state with confidence that the man could not have been, as it was alleged he had been, very severely flogged. The same remarks that apply to ordinary scars may be extended to the blue and red discolorations of the skin produced by the process of tattooing. They admit of removal only by the destruction of the portion of skin in which they are seated,

From what has been just stated it will be inferred that the exact shape and position of a scar may often prove of the utmost importance in determining a question of identity. Thus the operations of bleeding, cupping, and vaccination, like the punishment of the lash, leave appearances difficult to confound with those due to any other cause. So also with scars left by scrofulous ulcers on the neck, and by lupus on the face, by small-pox on every part of the body, and by burns and caustic.

Identification is sometimes effected, as in the following instance, by comparing a recent wound with the part of the body detached from it.

In January, 1846, a robbery was committed at Stigny, in a house inhabited by two old men. The next morning, when the robbery was discovered, several spots of blood were found on the floor on the left of a chest of drawers which the robbers had forced. Other spots of blood, rendered apparent by a fall of snow which had taken place the preceding night, were found following the direction taken by the robbers when they quitted the house. In every case the blood was on the left-hand side of the footsteps. A shred of membrane was also found on the road, which on examination was found to be a portion of skin. On searching the neighbourhood, a man was found with his hand wounded. Dr. Lemoine and M. Cœurderoi were appointed to examine him; and they both agreed that the wound, which was on the *left* hand, was probably inflicted about the date of the robbery, and that the piece of skin, judging from its dimensions and shape, had formerly covered the injured part. The accused confessed the crime. (Annales d'Hygiène, Janvier, 1847.)

Fraudulent discoloration of the Hair.—The question whether it is possible to change the colour of the hair from dark to light was raised in a case which occurred in Paris in the year 1832. A man named Bénoit, suspected of having committed murder, was tried before the Court of Assizes of the Seine. Certain witnesses deposed to having seen him in Paris at two in the afternoon with black hair; while others declared that they saw him at Versailles, at five or six o'clock the same evening, with fair hair. The man's hair was naturally jet black, and it does not appear that he wore a wig. The tribunal summoned Orfila, and Michalon, one of the first hair-dressers of Paris, to solve the following question: Is it possible to change the colour of the hair from dark to light? Michalon replied in the negative; but Orfila, on the contrary, declared that it was possible, and that twenty-

six years before (March 3rd, 1806), Vauquelin had read at the Institute a *mémoire* on the property which chlorine possesses of giving to black hair all the lighter colours, and even of changing it to white.

This case led to some careful experiments by Orfila, and subsequently by Devergie, in order to ascertain what changes in the colour of the hair might be effected by chemical means. Orfila examined the mode of effecting the change from light to dark, from dark to light, and from light red or chestnut to other shades of colour. Devergie limited himself to the verification of Orfila's experiments on the effect of chlorine in changing the hair from dark to light.

1. Modes of changing the hair from light to dark.

One method is by a mixture of charcoal and grease. This is easily detected by its soiling the fingers for days after its application, and by placing a lock of the hair in boiling water: the grease swims on the surface, and the charcoal falls to the bottom of the vessel.

A second method is to moisten hair, previously freed from its oil by liquor ammoniæ, with a solution of nitrate of bismuth. The hair, on being allowed to dry, is covered with the crystallized salt of bismuth. This is removed with distilled water, and the hair is again allowed to dry. Hair thus prepared, on being steeped for a quarter of an hour in a solution of sulphuretted hydrogen, was uniformly changed to black without being rendered brittle. When the oily matter of the hair was not previously removed, the change of colour was less complete.

The source of the change of colour in this case may be easily detected by treating the hair with dilute hydrochloric acid, or by a weak solution of chlorine. The hair is restored to its original colour, and the resulting liquid yields on evaporation a white residue, which, on being dissolved in distilled water, has all the characters of a salt of bismuth.

The acetate of lead employed in exactly the same way yielded similar, but less perfect results. The metal may be detected by the same means as in the case of the bismuth.

A mixture of litharge, chalk, and fresh lime, in the proportion of 3 parts litharge, 3 parts chalk, and 2 or 3 parts lime, was found still more effectual. This being dissolved in water, the hair is kept moist with it for three or four hours, and then allowed to dry. The chalk and oxide of lead attached to the hair are next removed with dilute acetic acid, and, lastly, the hair is rubbed with yelk of egg. The colour of the hair is thus effectually changed without any injury to its texture. These ingredients in variable proportions, according to the degree of change which it is desired to effect, compose the *Tinctura Pompeiana* of the shops. The cause of the change of colour can be detected by steeping the hair in dilute nitric acid, which dissolves all the ingredients with effervescence, leaving the nitrates of lead and lime in solution.

Similar results were obtained by means of the *plombite of lime*,

formed, by boiling, during an hour and a quarter, 4 parts of sulphate of lead, 5 parts of hydrate of lime, and 30 parts of water. The change of colour is not produced by this agent unless the hair be kept moistened with it for some hours.

Nitrate of silver gave to light hair a violet hue, which became darker by exposure to light. This agent was easily detected by the colour of the hair, and by steeping it in a solution of 1 part of chlorine to 4 of water. A clotted chloride of silver is thus formed, which may be identified by its appropriate tests.*

A mixture of sulphate of mercury and oxide of copper dissolved in dilute acetic acid answered less perfectly than the preparations of lead.

2. Mode of changing the hair from dark to light.

The results of numerous experiments performed by Orfila and Devergie with solutions of chlorine of different degrees of strength, may be thus summed up. Black hair may be changed to various lighter shades; as dark and light chestnut, dark and light blond, yellow, and yellowish white, by being steeped or washed a longer or shorter time in solutions of chlorine of different strengths. Hair combed with a solution of chlorine is but slightly changed even after many repetitions of the process; and there is reason to believe that Orfila erred in supposing that it would be possible to obtain the marked effects produced by soaking the hair in a solution of chlorine if it were merely combed with that fluid for many hours. The chlorine is readily detected by its odour, even after washing the hair as many as fifty times with water; the colour of the hair is peculiar, by no means uniform, and not easily confounded with any natural colour; and the hair itself is hard, stiff, and brittle. These results are in strict accordance with those of my own experiments. Specimens of dark hair treated with chlorine, and of light hair treated with the Tinctura Pompeiana, are preserved in the Museum of King's College.

All these processes for changing the colour of the hair occupy some time, and, with due care, it is easy to detect the fraud that has been practised. If the question were actually raised in a court of law, the hair might be allowed to grow, taking care that the suspected person had no access to any dye; or the shorter process of analysis might at once be used.

It may be well to state in this place that the hair sometimes undergoes a very marked change of colour in the course of some processes of manufacture. In turning rulers, for instance, out of the wood known as "green ebony," light hair is permanently changed to a green, and a similar change of colour results from working in an atmosphere containing copper in fine division.

The effect of sudden and violent emotion in turning the hair gray is well known. Such quick change of colour is also known to be

* A more natural colour may be imparted to the hair by the production of a sulphide of silver; or of some of the compounds developed in the practice of photography.

occasionally due to disease and to other obscure causes. One remarkable case of a complete change of colour in the hair of the whole body is related by Dr. Gordon Smith. The change took place in a girl thirteen years of age in a single night, and was not immediately preceded by any indisposition or by any emotion which could account for it. The change thus produced is sometimes permanent; but in some cases the natural colour of the hair has been restored.

One other question relating to the identity of the Living remains to be examined, viz., *What degree and duration of light are necessary to enable an observer to distinguish the features, so that the person may be afterwards identified?* That a very short duration of a brilliant light is sufficient for this purpose will appear from a case related to Dr. Montgomery by one of his patients. A lady, on her passage from India, awoke in the middle of the night, and heard some one stirring in her cabin, but could see nothing, it being quite dark; when suddenly the cabin was so completely illuminated by a flash of lightning, that she could see distinctly a man rummaging one of her trunks, and discerned his features so accurately that she identified him next morning: some of the stolen things were found upon him, and he subsequently acknowledged the fact.*

In a case which occurred in France about half a century ago, the question was raised whether the light produced by the flash of a pistol was sufficient to discover the face of the person firing.

The Sieur Labbe, Mayor of the commune of Foulanges, in the department of the Calvados, on a dark night in the month of May, 1808, was passing on horseback along the highway with the widow Beaujean, when his servant, who was on foot, was fired at with a gun through a hedge bordered by a ditch, and wounded in the hand. Both Labbe and his servant swore that they recognized the assassin by the light of the discharge. One of the accused was arrested, tried, and condemned to death; but an appeal being taken to the Court of Cassation, M. Lefevre Gineau, Member of the Institute, and Professor of Experimental Physics in the Imperial College of France, was consulted as to the possibility of an identification in the manner described. Accordingly, Gineau, his son, Professors Dupuis and Caussin, and several others, retired into a dark room, where several primings were fired, the spectators being stationed at different distances, to witness the effect. The light produced was strong, but fuliginous, and so rapidly extinguished, that it was impossible to distinguish the individual firing. "It was scarcely possible to see distinctly the form of a head, and that of the face could not be recognized." The experiments were then repeated in the court-yard of the college, the gun being loaded with powder, but with the same results. The sentence was reversed.†

These experiments do not appear to have convinced Fodéré, who thought that if the night were dark, and the persons within six, eight,

* 'Cyclopædia of Pract. Med.,' art. Identity.

† Quoted by Beck from the 'Causes Célèbres.'

or ten feet of each other, such events as those now related are possible; and the results arrived at by the French experimenters are certainly at variance with the opinions of persons accustomed to the use of fire-arms, as well as with some experiments made by the author, who repeatedly recognized the face of a person with which he was familiar by the discharge, in the dark, of a gun close at hand. It may also be reasonably contended, that under the influence of strong excitement the perceptions are uncommonly acute, as the actions are unusually rapid. It might happen, therefore, that a person exposed to danger would have a quicker and more distinct perception than an experimenter. The question, therefore, is one which admits of satisfactory solution only by collecting cases occurring under circumstances of intense excitement.

The following case, which occurred in England in 1799, is of this nature:—"A man named Haines was indicted for maliciously and feloniously shooting at Edwards, Jones, and Dowson, Bow Street officers, on the highway. Edwards deposed that, in consequence of several robberies near Hounslow, he, together with Jones and Dowson, was employed to scour that neighbourhood; and that they accordingly set off in a post-chaise on an evening in November, when they were attacked near Bedfont by two persons on horseback, one of whom stationed himself at the head of the horses, and the other went to the side of the chaise. The night was dark; but he swore that from the flash of the pistols he could distinctly see that the man rode a dark-brown horse, between thirteen and fourteen hands high, and of a very remarkable shape, having a square head, and very thick shoulders, and altogether such that he could pick him out of fifty horses: he had afterwards recognized the horse. He also perceived by the same flash of light that the man at the chaise-door had on a rough shag-brown greatcoat." *

The reader will find a French case in confirmation of the foregoing in the Introduction to Foderé's 'Treatise' (note, p. 28).

2. IDENTITY OF THE DEAD.

In cases of death by accident or violence, and in cases of exhumation, the medical man may be required to identify the dead. Sometimes he is called upon to assist in identifying the entire body, or one which has been mutilated, but, in other cases, to examine with the same object the skeleton, or such parts of it as may be found, with a view of determining the sex, age, and probable stature of the person to whom the fragments belong.

When the entire body is the subject of examination, the same mistakes may be committed as in the case of the living. It may be supposed to be that of some person actually living at the time; of which error there is more than one instance on record.

* Montgomery: 'Cyclop. of Pract. Med.,' art. Identity.

There are many successful cases of identification upon record, of which the following are examples:—

In the year 1814, Dupuytren identified the person of a murdered man chiefly by means of a malformation of the hip-joint. The existence of a similar deformity enabled MM. Laurent, Noble, and Vitry, in 1828, to identify a man who had been buried in a cellar at Versailles three years. The body of Maria Martin was identified eleven months after her death by the absence of certain teeth from the upper and lower jaw, and by signs of inflammation, with extensive adhesions of the pleura, answering to an attack of inflammation of the chest, from which she was proved to have suffered shortly before her mysterious disappearance. A doubtful case, tried at Edinburgh, was decided by a dentist, who produced a cast of the gums which he had taken before death. The scanty remains of the body of the Marchioness of Salisbury, discovered among the ruins of Hatfield House, were also identified by the jaw-bone having gold appendages for artificial teeth; and the identification of the body of Dr. Parkman, murdered by Dr. Webster, the American chemist, was greatly assisted by the very peculiar formation of the jaw, and the correspondence of a portion of it with a cast taken by a dentist.

In some remarkable instances the work of identification has consisted in discovering, after a considerable period of interment, the bodies of celebrated personages about whose real burial-place a doubt had been raised. In other instances the body has been completely identified by the close resemblance of the face of the corpse to extant pictures, or by other similar means. The identification of the remains of Henry IV. in Canterbury Cathedral, after the lapse of nearly four centuries and a half, is an example of the first class of cases; the identification of the remains of Charles I., of the second class. The remains of Charles I. were completely identified by the striking resemblance of the countenance, notwithstanding its disfigurement, to his portrait on coins, busts, and paintings. The fourth cervical vertebra was also found divided transversely, the corresponding surfaces being smooth, showing that they had been separated by a heavy, sharp instrument. An interesting narrative of this exhumation was published by Sir Henry Halford, and a detailed account of the search after the body of Henry IV., in Felix Summerley's 'Handbook for Canterbury.'

The cases of mistaken identity in the living have their parallels in the dead, as the following case will show:—

A resurrection-man was tried for raising the body of a young woman from the churchyard of Stirling, nine weeks after death. The body was identified by all the relations, not only by the features, but by the left leg being shorter than the right. The jury was convinced that the *libel was proven,* and gave a verdict accordingly. "Now I am certain that this was not the body of the woman who was taken from the churchyard of Stirling, but one that, at least six weeks after the time libelled, was buried in the churchyard of Falkirk, from which she was

taken by this man, who also took the other for which he was tried; she also was lame of the left leg: thus, though guilty of the offence laid to his charge, he was found guilty by a mistake of the *corpus delicti.*"—(Dunlop, note to Beck's 'Medical Jurisprudence.')

Cases illustrative of the possibility of dead persons being mistaken for living ones, not merely by acquaintances and friends, but by parents and near relations, are recorded by Smith, and by Dr. Cummin in his lectures. ('Medical Gazette,' vol. xix.)

Calculation of the Stature from the length of a part of the body.—Attempts were made by M. Sue as much as a century ago, to furnish data for calculating the stature from the length of the extremities.* He measured subjects of medium height, chosen from appearing to him well proportioned. Some of the numbers are averages; others the result of only one measurement. The following table presents these measurements reduced to English feet, inches, and lines:—

Age.	Body.			Trunk.			Upper Extremity.			Lower Extremity.		
	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.
1 year . .	2	0	0	1	2	5	0	9	7	0	9	7
3 years . .	2	11	3	1	8	4	1	3	0	1	3	0
10 years . .	3	11	0	2	1	7	1	8	4	1	9	11
14 years (average)	4	10	8	2	5	11	2	4	1	2	4	10
20-25 years (average)	5	8	2	2	10	1	2	8	0	2	10	1

M. Sue states, that towards the 20th, and from that to the 25th year, the superior border of the symphysis pubis forms the exact centre of the body, and that this centre continues constant for more advanced ages, except that in old age the spine becomes curved. Before the adult age, the centre of the body varies according to the age.

These measurements of M. Sue have been repeated by Orfila, both for the subject and for the skeleton;† with the result of showing that the statements of M. Sue must be received with caution. Thus of 44 males, who with 4 exceptions were adults, there were only 7 in whom the length from the vertex to the pubes was exactly equal to the length from the pubes to the sole of the foot; whilst in 23 instances, the former measurement exceeded the latter; and in 14 fell short of it. The greatest difference on either side was 2⅓ inches English. Again, out of 7 females submitted to measurement, there was not one in whom

* 'Sur les Proportions du Squelette de l'Homme.' Mémoires présentés à l'Académie Royale des Sciences, tom. ii. 1755.

† 'Traité de Médecine Légale,' tom. i. p. 105.

the above measurements were equal, and the upper half of the body was longest in 6 and shortest in one. The males on an average were longer from the vertex to the pubes by more than $\frac{1}{3}$ inch, the females by $1\frac{1}{6}$ inch. On pursuing the examination of the tables still further, and bringing together the instances in which the length from the vertex to the pubes happens to be the same, a considerable difference is found to exist in the length from the pubes to the sole of the foot. Thus of fifteen males measuring 2 feet 9 inches or 2 feet $9\frac{1}{2}$ inches from the vertex to the pubes, one measured as little as 2 feet 7 inches from the pubes to the sole of the foot, while another measured 2 feet $11\frac{1}{2}$ inches —a difference of $4\frac{1}{2}$ inches. Again, of five females, in whom the upper measurement was 2 feet $6\frac{3}{4}$ inches to 2 feet 7 inches, one measured little more than 2 feet 4 inches, the other little less than 2 feet 8 inches —being a difference of nearly 4 inches.

So that in making use of Orfila's measurements for the purpose of determining the stature of the body, we might be in error to the extent of from 4 to $4\frac{1}{2}$ inches. On turning to Orfila's table of measurements of the skeleton, we encounter still more remarkable deviations from the rule laid down; for in one instance in which the upper part of the body measures 3 feet $1\frac{1}{2}$ inch, the lower part measures only 2 feet 8 inches, being a difference of $5\frac{1}{2}$ inches; and, in another instance, in which the upper measurement was 2 feet $5\frac{1}{2}$ inches, the lower measurement was 2 feet $11\frac{1}{2}$ inches, being a difference in the opposite direction of 6 inches. It follows, then, that the statements of M. Sue are much too general to be used for purposes of great accuracy; and that in making use of the more exact measurements of Orfila, as means of determining the stature of the body, we might commit very serious errors.

M. Orfila's measurements of the several cylindrical bones, from which he proposes to calculate the stature of the skeleton and of the living body, also yield, as the subjoined table will show, very unsatisfactory results:—

Stature of the Skeleton calculated from the Length of the Cylindrical Bones.—(From Orfila's second table.)

					STATURE.							
					Max.			Min.			Difference.	
		Ft.	In.	Lin.	Ft.	In.	Lin.	Ft.	In.	Lin.	In.	Lin.
Humerus	6 obs.	1	1	0	6	1	3	5	9	9	3	6
Ulna	7 „	0	10	8	6	1	3	5	5	0	8	3
Femur	7 „	1	6	1	6	0	0	5	7	0	5	0
Tibia	7 „	1	3	0	5	10	6	5	5	0	5	6

Stature of the Body, calculated from the same data.
(From Orfila's first table.)

			STATURE.		
			Max.	Min.	Difference
		Ft. In. Lin.	Ft. In. Lin.	Ft. In. Lin.	In. Lin.
Humerus	19 obs.	1 2 6	5 8 1	5 4 6	3 7
Ulna	14 „	0 10 8	5 10 10	5 5 8	5 2
Femur	12 „	1 5 9	5 9 8	5 4 6	5 2
Tibia	11 „	1 2 5	5 9 8	5 4 6	5 2

It would appear, then, that for the same length of cylindrical bone, we may have a variation in the length of the skeleton of from $3\frac{1}{2}$ to $8\frac{1}{4}$ inches; and in the length of the body of from more than $3\frac{1}{2}$ to more than 5 inches.

This minute analysis of the tables of M. Orfila has been rendered necessary by the undue importance which he himself attached to them; for he says, "we are certain that it will be possible in the greater number of cases, on consulting these tables, and on having regard especially to the lengths of the femur and humerus, to arrive sufficiently near the truth." This excess of confidence on the part of M. Orfila arose from his not having really examined his own figures. Such an examination was the more desirable, as the high authority of M. Orfila has led to the use of his figures for practical purposes. Thus, Dr. Henri Bayard, in three instances, in which the only portions of the body left were the bones, applied Orfila's data; in two unsuccessfully, but in the third case with a success which is obviously attributable only to a happy coincidence. The following are the particulars of this case. The stature of the body, calculated from the measurement of the long bones of the upper and lower extremities, was 1 mètre 54 centimètres. It was highly probable from the circumstantial evidence that the skeleton belonged to one Adnet, who had disappeared two years previously. Adnet's wife stated that her husband was as nearly as possible of her own height, and that he could wear her shoes. She measured 1 mètre 52 centimètres. A certificate under the hand of the mayor of the commune in which Adnet resided, gave as his height, determined for the purposes of the conscription, 1 mètre 53 centimètres. So that the calculated stature (1 mètre 54 centimètres) corresponded very closely with the ascertained stature. ('Annales d'Hygiène,' April, 1845, p. 379, and 'Ranking's Retrospect,' vol. ii., p. 422.)

The following table presents the average measurements in English feet, inches, and lines, obtained from forty-four male and seven female subjects.

	Stature.	Vertex to Pubes.	Pubes to Foot.	Upper Extremity from Acromion.	Femur.	Tibia.	Fibula.	Humerus.	Radius.	Ulna.
Male.	5 6 6	2 9 6	2 9 0	2 5 6	1 5 8	1 2 7	1 2 2	1 0 5	0 9 5	0 10 2
Female	5 1 0	2 7 1	2 5 11	2 2 8	1 4 6	1 1 9	1 1 5	0 11 7	0 8 8	0 9 9

AGE.

The law makes many distinctions in regard to Age, and defines with much minuteness the privileges, immunities, and responsibilities which belong to the several periods of life. It rarely happens, however, that the medical man is required to give evidence on this point; and the occasions on which his opinion may be required will become less numerous as our system of registration of births comes into more complete operation.

It is chiefly as a preliminary means of identification that the question of age is important, and, like the general question of identity, it divides itself into two parts. 1, The Age of the Living; and 2, The Age of the Dead.

1. MEANS OF DETERMINING THE AGE OF THE LIVING.

Many attempts have been made to give to this subject an air of importance, and much learning has been expended upon it. The arbitrary division of human life into several periods, the equally arbitrary assumption of certain ages as periods of unusual importance and danger (the climacterics), and the laboured general description of the changes which take place in the external appearance of the body and in the faculties of the mind—all these are wanting in the precision necessary for medico-legal purposes; and the same remark applies to the calculations of M. Quetelet, based upon the ascertained stature and weight of the body at different periods of life.

The same objection applies to the position of the centre of the body as a test of age. It may be stated, in general terms, that the centre of the body at birth is at the umbilicus; in the adult, at the pubes; for the intermediate ages, at intermediate points, nearer to the umbilicus in the infant, and to the pubes in those approaching the adult age; and that in the female, in consequence of the lower extremities, but especially the thigh bones, being shorter than in the male, the centre of the body is above the pubes.

The facts collected in illustration of the period of puberty in the two sexes, and of the change of life in the female, also show the little dependence that can be placed on these occurrences as indications of age. The extremes are so far apart in all observations belonging to

this class, that it would be unsafe to apply the average results to individual cases.

During the periods of childhood and boyhood we possess more precise, though still very imperfect, means of ascertaining the age in the successive appearance of the teeth both of the first and second dentition.

The following is the order and probable period of the appearance of the first set or milk-teeth.

Central incisors	5— 7 months.
Lateral incisors	6— 9 ,,
First molars	8—15 ,,
Canine teeth	15—18 ,,
Second molars	18—24 ,,

The milk-teeth, then, make their appearance at different times in different children. Some are born with the incisors above the gums; others have no teeth till the end of the second year; and others, again, live many years without having a single tooth. Too much reliance, therefore, must not be placed on this test of age.

The following table presents the order and probable time of the appearance of the permanent set of teeth, with the number of teeth existing at each age.

AGE.	INCISORS.		Cuspids.	BICUSPIDS.		MOLARS.		
	Central.	Lateral.		Anter.	Poster.	Anter.	Second.	Poster.
7 years .	..	..	..	..	..	4	..	..
8 years .	4	..	..	..	..	4	..	..
9 years .	4	4	..	..	..	4	..	..
10 years .	4	4	..	4	..	4	..	..
11 years .	4	4	..	4	4	4	..	..
12—12½.	4	4	4	4	4	4	..	..
12½—14.	4	4	4	4	4	4	4	..
18 —25.	4	4	4	4	4	4	4	4

As it was important to ascertain how far this table might be employed as a standard of comparison in determining the age of children, especially of those employed in factories, Mr. Saunders* selected the two periods of 9 and 13 years, observed the number of teeth existing at those periods in many hundred children, and obtained the following results:—

Out of 457 boys 9 *years of age*, 219, or nearly one-half, had the number of teeth stated in the foregoing table; namely, 4 central incisors, 4 lateral incisors, and 4 anterior molars. Of 251 girls, of the same age, 168, or considerably more than one-half, had the same num-

* 'The Teeth a Test of Age.' By Edwin Saunders.

ber of teeth. Taking the two sexes together, 387 out of 708 had the full complement of teeth. The remainder in both sexes consisted of children who in place of the full number of 4 of each kind of teeth, had a smaller number of one or the other. Thus in a large proportion of the children, one, two, or three, out of the four lateral incisors were wanting, and so of the other teeth. In 52 cases only the lateral incisors were entirely wanting.

If, then, in each column of the foregoing table, opposite the age of 9 years, we substitute for the number 4, the numbers 1, 2, 3, or 4, and assert that wherever any of those numbers of teeth are found to exist, there we may assume that the child is in its 9th year, our assertion will be borne out in 656 out of 708 cases, or in about 13 in every 14 cases. In the remaining cases, 52 in number, a child of 8 years might, by the use of the foregoing table, be mistaken for one of 9 years old.

The following are the results of the inquiry respecting children who had attained the age of 13 years:—

Rather less than half the boys, and more than half the girls, and as nearly as possible half of the two sexes taken together, had the full complement of teeth entered in the table as belonging to children of 12½ to 14 years of age: by far the majority of both sexes had one or more of the several orders of teeth: and in 11 instances only were some or other of the teeth entirely wanting. In three cases a child of 13 might have been mistaken for one of 12 to 12½ years; in one instance for one of 11, and in one instance for one of 10. In a vast majority of instances, however, we should be justified in stating that a child having one or more of the several teeth indicated in the table opposite to the period of 12½ to 14 years had completed its 13th year.*

The permanent set of teeth is not complete till the *dentes sapientiæ* have made their appearance. This usually happens from the 18th to the 25th year, but it sometimes takes place much later; and one case is recorded by Dr. Hamilton of a man of 80 who died from the irritation produced by cutting his wisdom-tooth.

Among the signs of age on which some stress has been laid is the white line around the margin of the iris,—the *arcus senilis*. As the author has seen this circle completely formed in one man of 42, and in another of 39, and absent in a man of 79, and in another of 85; and as the cause of the arcus has been proved to be a deposit of oil-globules in the iris, which may take place from causes other than advancing age, this appearance must be rejected as a test of age.

All other indications of age in the Living, such as grayness or baldness of the hair, and the loss of teeth, are deceptive. Cases of premature old age, of unusual vigour at advanced periods of life, and of restoration in the aged of some of the structures and functions proper to an early period of life (*e.g.* the cutting of teeth and the growth of coloured

* The results here stated in general terms were given in the first edition of this work in a tabular form.

hair; the secretion of milk, and the persistence or return of the menstrual discharge), will sometimes prevent us from even guessing at the age with any accuracy. On the other hand, the early occurrence of the marks of puberty in both sexes, and the premature or very late appearance of the menses in the female, create difficulties in rightly estimating the age at an earlier period of life.

2. MEANS OF DETERMINING THE AGE OF THE DEAD.

In examining the bodies of persons recently dead, we have the same means of estimating the age which we possess in the case of the living. There are instances, too, in which we may derive some advantage from the dissection of the body. Bony deposits in the heart and arteries would afford a strong probability that the subject had reached at least a mature, and probably an advanced period of life.

The state of the osseous system will also furnish some clue to the age, both at the earlier and later periods of life. The imperfect ossification of the bones, and of their processes and epiphyses, and the condition of the cartilages of the larynx and ribs, will afford us some assistance in infancy, childhood, and youth.* At the other extreme of life, marked changes in the osseous system also take place. The internal cavities of the bones increase, from the absorption of the osseous matter, and the bones from the same cause become lighter. The bones of the head are solidly united, but, on account of the absorption of their diploe, become thin. The spinal column is curved. The cartilages of the larynx and ribs are completely ossified. The osseous tissue generally is more dense, dry, and fragile, and abounds in earthy materials. In very old persons the appearance of the lower jaw is highly characteristic. The body is very shallow, owing to the absorption of the alveolar border, and the angle is obtuse, as in childhood. This appearance of the jaw in extreme old age is shown in the annexed engraving.

Fig. 1.

* The reader will find very minute details of the progress of ossification in its relation to age in Orfila's treatise (vol. i., p. 106); in Béchard's 'Anatomie Générale,' p. 495; and at p. 31 of the first edition of this work.

SEX.

This subject, like the foregoing, divides itself into two parts. 1, The means of ascertaining the Sex of the Living; and 2, The means of determining the Sex of the Dead.

1. SEX OF THE LIVING, INCLUDING THE SUBJECT OF DOUBTFUL SEX.

The question of sex may be submitted to the medical man in reference both to infants and adults. In the case of a new-born child, the issue of parents possessed of real or landed property, the right of succession, and should it die, the disposal of the property, must depend on the determination of the sex. If a wife, being tenant in tail-male, is delivered of a son born alive, the husband's right is secured; but the property passes from him if she gives birth to a daughter. This form of succession is termed 'tenancy by the courtesy.'

It may be necessary also not merely to ascertain the sex, where that can be done, but in doubtful cases, to determine which sex most predominates; for it appears, on the authority of Coke upon Littleton, that "an hermaphrodite, which is also called Androgynous, shall be heire, either as male or female, according to that kind of the sexe which doth prevail, and accordingly it ought to be baptized."

The question of sex may also arise at a later period of life, as in the case quoted by Beck of a young nobleman of doubtful sex, whose parents consulted a medical man whether he should be educated as a male or female.

There are three different conditions of the organs of generation which may present difficulties to the medical examiner.

1. The male organs may resemble the female.
2. The female organs may resemble the male.
3. The organs of the two sexes may be blended, some one or more organs of the one sex being superadded to, or substituted for, those of the other.

1. The male organs may resemble the female. (Androgyni.) The most common malformation of this sort consists of a small, imperfect, and imperforate penis, a short canal beneath it, and a cleft scrotum, these parts bearing respectively some resemblance to the clitoris, vagina, and labia of the female. Each section of the scrotum sometimes contains a testicle, but in other instances those organs, one or both, are situated behind the external ring. The short canal, or *cul de sac*, which replaces the urethra, and is found to communicate with the bladder, opens at the base of the penis, or in the perineum, near the anus. It is often enlarged at its commencement, so as to resemble the vagina; and instances have occurred in which sexual intercourse has taken place through this enlarged canal of the urethra. From the

position of the opening of the urethra beneath the imperforate penis, these persons are called *hypospadians.*

The existence of the testicles in the folds resembling the labia, or in the groin, the communication of the opening beneath the imperforate penis or in the perineum with the bladder, the absence of any organ corresponding to the uterus, and, in the adult, the absence of menstruation,—will enable us at once to distinguish the sex. In most of these cases the conformation of the body nearly approaches that of the male. The development of the muscles, the tone of the voice, the tastes and habits, are more those of a man than of a woman. Nevertheless there are cases in which an enlargement of the breasts, coupled with a preference for the society of the male, might lead us into error in the absence of a careful examination of the organs of generation. In other instances the sexual passion is absent. Several cases answering to this description have been put on record;* and there are preparations illustrative of these malformations in most of our museums. A single case, published by Mr. W. Loney in the 'Lancet,' May 7, 1856, will suffice for the purpose of illustration. "Jane W——, 28 years of age, was admitted into the lunatic ward of the Macclesfield workhouse. Her unwillingness to be washed excited suspicion, and led to her being examined; when it was found that she had a penis two inches long, and the same in circumference, placed on the pubes, just above and between the external labia; it had a well-defined prepuce, which could be moved at pleasure, causing a slight erection. The opening into the vagina, which was just below, was so small as to admit the little finger with difficulty; and a ligamentous band could be felt at about three inches distance from its mouth. The urethra could not be seen, but a catheter was passed into the bladder through the vagina. There was no opening in the penis. The hair of the head was short and curly, like a man's; the limbs very muscular and hairy; and the voice exceedingly rough and masculine. The mammæ were entirely absent, and there was more hair than usual about the pubes. She had never menstruated. Her taste was very depraved, as she would eat old poultices with great delight. She was strong and healthy, and annoyed the young women in the same ward by the display of her amatory propensities."

Sometimes the penis, whether well or ill formed, is found confined to the scrotum by a particular formation of the integuments. This malformation, with the other deviations from the normal structure just described, occurred in two cases, one a negro, the other a European, of which Cheselden gives engravings; and in the case of a child baptized and brought up as a girl, Mr. Brand by a slight incision liberated the restricted parts, and proved to the parents that they had mistaken the sex of their child.

Another malformation belonging to this division, and which might

* See Beck's 'Elements of Medical Jurisprudence,' vol. i. p. 172.

possibly give rise to doubt as to the sex, consists in a deficiency of the anterior wall of the urinary bladder, and of the lower and anterior portion of the abdominal parietes, their place being occupied by a red and sensitive mass of an irregular form, with the ureters opening upon it. The penis is short, imperfectly formed, and imperforate. The vesiculæ seminales open near the red and sensitive surface just described, or in a small tubercle at the root of the penis. The testicles are generally well formed, sometimes contained in the scrotum, sometimes to be felt in the groin, or they have not descended. The sexual appetite in some of these individuals is weak; in others strong; in others altogether wanting. The persons who have this malformation are called *Epispadians*.

2. The female organs may resemble the male. (Androgynæ.) An enlarged clitoris is the most common form of malformation belonging to this class. None of the recorded cases presented any real difficulty, though some have excited great interest. The absence of testicles from the labia, the presence of a vagina and uterus, the occurrence of menstruation, either of these singly or all combined, render the distinction easy.*

A prolapsus uteri has more than once given rise to a question of sex. Sir Everard Home mentions the case of a Frenchwoman suffering from this disease who laid claim to the male sex, and was shown as a curiosity. The prolapsus was evident on inspection. And Mahon relates the case of one Margaret Malaure, who came to Paris in 1693, dressed as a man. She alleged that she possessed and could use the organs of both sexes. She, too, was exhibited; and several physicians and surgeons gave certificates that she was an hermaphrodite. But Saviard, an eminent surgeon, was incredulous. He examined her in the presence of his brother practitioners, and found that she had a prolapsus uteri, which he reduced.

3. The organs of the two sexes may be blended, some one or more organs of the one sex being superadded to, or substituted for, those of the other.

Many cases of this imperfect approach to the true hermaphrodite are on record. In some instances an ovary has been found on the left side, and a testis on the right; in others the position of these two organs has been reversed; and in a third class of cases the external organs have approximated closely to the female type, and the internal to the male, or the reverse.†

It is unnecessary to add that no case of real hermaphroditism, in other words, of a blending of the organs of the two sexes in a state of perfect development in the same person, is on record.

* See the cases illustrative of this malformation detailed at length in 'Cyc. of Anatomy and Physiology,' art. Hermaphroditism.

† See the case of Durrje or Derrier in Cummin's Lectures, 'Med. Gaz.,' vol. xix.: and for cases of the last-named malformation, occurring both in man and animals, see the very complete and learned paper on Hermaphroditism by Dr. Simpson, in the 'Cyclopædia of Anatomy and Physiology.'

In examining cases of doubtful sex, the following points must be taken into consideration:—The size of the organ corresponding to the penis or clitoris, and whether it is perforate or imperforate; the form and mode of attachment of the prepuce; the presence or absence of parts corresponding to the nymphæ; the presence or absence of the testicles. The openings which exist must be carefully examined with a sound, to ascertain whether they communicate with the bladder or uterus, or are merely *culs de sac;* and inquiry should be made respecting the existence of the menstrual discharge, or of vicarious discharges. The character of the voice should be observed, and the conduct and feeling of the person under examination towards either sex should be ascertained. The general conformation and appearance of the body should also be observed, including the growth of the beard,* and of hair on different parts of the body; the formation of the shoulders and hips; the development of the breasts; and the fulness of the thighs.

2. SEX OF THE DEAD.

When the entire body is submitted to our inspection, we shall find no difficulty in determining the sex, except in those rare instances in which the characters of the two sexes are blended. In some of these cases dissection will enable us to ascertain the sex where it would scarcely be possible to come to any decision during life.

But when the question of sex is raised after death, it is generally in reference to the skeleton or some part of the osseous system, in which the following differences are observable:—

The *bones* of the female are lighter, more cellular, less marked by asperities, and less curved by muscular action, than those of the male: the processes are less strongly marked, and the joints smaller. The *skull* of the female is smaller, more oblong, less depressed at the sides, and of greater length behind the foramen magnum; the face is more oval, the frontal sinuses less strongly marked, the nostrils more delicate, the jaws and teeth smaller, and the chin less prominent. The *chest* of the female is deeper than that of the male; the sternum is shorter and more convex; the ensiform cartilage thinner, and ossified later in life; the ribs smaller, and their cartilages longer. The *vertebral column* is longer, and the bodies of the vertebræ are deeper in the female than in the male. The *pelvis*, however, of the two sexes presents the most striking contrast. The ossa ilia are more expanded and horizontal in the female; the sacrum more concave; the pubes more shallow; the angle formed by the descending rami more obtuse; the pubic arch wider; the tuberosities of the ischia more largely separated;

* The curious case published by Dr. Chowne of an otherwise well-developed female with a copious beard and whiskers, supplies us with a caution not to attach too much importance to any one of the signs detailed in the text. For the case itself, and a learned history of similar instances, see 'Lancet,' for 1852, vol. i. p. 421.

the foramen ovale larger, more triangular, and more oblique; the acetabula wider apart; the entire pelvis more shallow, but larger in its outlets than in the male. These differences between the pelves of the two sexes is shown in the annexed engravings, in which A represents the male, and B the female pelvis.

The difference between the male and female skeleton is less strongly marked before the age of puberty.

Fig. 2.

A well-formed adult female pelvis measures at the brim about $4\frac{1}{2}$ inches from before to behind; about 5 inches from side to side; and about $5\frac{1}{8}$ inches obliquely. At the outlet it measures 4 inches from before to behind, and the same from side to side.

This group of subjects—identity, age, and sex—cannot be better brought to a close than by a case in which the question of identity was involved, and the distinctions just laid down in respect to age and sex practically applied.

Case of the widow Houet.—In this case, which occurred in Paris, proof of identity was successfully deduced from the remains of a female who had been interred eleven years. The official report was drawn up by MM. Orfila, Chevallier, Barruel, and Boys de Loury.*

In the year 1821, a widow lady of the name of Houet, residing in the city of Paris, disappeared; and certain persons, Bastien, Robert, and Robert's wife, were suspected of having made away with her. A judicial inquiry was pending for some time in the Court of Assize; but the accused, for want of evidence, had been set at liberty. Some information, however, was subsequently obtained touching a body said to have been buried for about eleven years in a particular garden; and by means of a patient and ably directed research, such satisfactory evidence was procured of the identity of the remains, and of

* For a very full account of this case, refer to Cummin's Lectures, 'Medical Gazette,' vol. xix.

the manner of the death, that the prisoners were convicted and punished.

The first part of the inquiry—the juridical exhumation—was conducted by M. Boys de Loury. After excavating different parts of the garden for about five hours, one of the workmen hit upon a hollowed spot, which, on being carefully opened, was found to contain the remains of a human body, reduced almost to a skeleton. A drawing was made of the parts *in situ*. The figure lay on the left side, with the head bent forward upon the neck, the vertebral column curved, the right fore-arm raised, so that the bones of the hand nearly touched those of the face. The pelvis was turned obliquely upwards, resting on the left haunch. The thigh-bones were raised considerably, and the legs were crossed beneath them. The prevailing colour of the remains was between an ochre and a brown, but the parts in contact with some of the long bones were of a deep-red tint.

The bones were small and delicate: those of the extremities were not at all curved by muscular motion, the marks of the insertion of the muscles were few and faint. Among the bones of the left hand was found a gold ring, of small diameter, carved in *facettes;* and several small well-formed finger-nails were also discovered. The cranium was small, and oblong from front to rear; the parietal bones were very yielding; the sutures were well-knit; the teeth were white and well preserved, but three molars were wanting, and one of the incisors was carious. A small quantity of light-coloured, or ruddy hair was found, having some gray hairs mixed with it. The ossa innominata were largely spread out; the cavity of the pelvis not deep; the anterior part of the sacrum concave; the sub-pubic holes triangular; the cotyloid cavities wide asunder: finally, the upper opening of the pelvis presented exactly the diameters usually found in well-shaped females. So that, putting all these characters together, there cannot be a doubt but that this was the skeleton of a woman.

The state of the neck was particularly striking. The third, fourth, fifth, and sixth cervical vertebræ, as well as the right clavicle, were held together by a blackish mass, surrounded at its lower part by several twists of a cord two lines in diameter; the cord was in a very decayed condition, and no knot could be found upon it. Minute attention was subsequently given to this *pièce de conviction,* and the obvious inference, that the deceased had been strangled, was fully borne out by all the direct and collateral circumstances.

Several elaborate documents were drawn up by the reporters; of the first of which the following is a *résumé:*—

"From the preceding facts, we feel ourselves justified in concluding,

"1. That these bones are those of a *human* skeleton.

"2. That the skeleton is that of a *female.*

"3. That this female had attained the *age* of from 60 to 70.

"4. That her stature was about 4 feet 8 or 9 inches (nearly 5 feet Eng.).

"5. That the hair of the female, which was of a bright blond colour in youth, was mixed with gray at the time of her death.

"6. That the hands were small.

"7. That during life the bones had never suffered any injury.

"8. That this woman died of strangulation, and that the act was, to all appearance, homicidal; and

"9. That the body must have lain for several years in the earth."

The prisoners, who had been long suspected, were brought to trial, condemned, and sentenced to forced labour for the remainder of their lives.

CHAPTER II.

IMPOTENCE. RAPE. PREGNANCY. DELIVERY.

In the last chapter the subject of sex was examined as a means of identification; in this it is considered in relation to the generative function, and comprises the subjects at the head of the chapter.

IMPOTENCE.

The medical man may be required to ascertain whether or not a man is impotent, or incapable of sexual intercourse. 1. In suits for divorce. 2. In cases of contested legitimacy; and 3. In accusations of rape. The question of incapacity for sexual intercourse has been so rarely raised in the case of females, that the term impotence, though equally applicable to women and men, has been used only in reference to the latter. As, however, there is an obvious distinction between impotence and sterility in women as in men, the meaning of the word impotence is here extended so as to embrace both sexes.

Marriage, regarded as a contract entered into by two parties, presupposes, as do all other contracts, a free exercise of the will, and ability to fulfil the terms of the contract.

The first condition, the free exercise of the will, comes into question in those cases in which marriages have been brought about by the exercise of undue influence upon either party to the contract, and it is alleged that the person so influenced was of weak or unsound intellect. The consideration of this class of cases belongs to the subject of unsoundness of mind.

Before proceeding to consider the second condition—ability to fulfil the terms of the contract—it may be well to premise that, in order to establish a ground for divorce, corporeal imbecility must not only be proved to have existed *before* the marriage, but to be irremediable. In most suits of divorce, the medical man is called upon to examine the person of the husband; but if the husband is not forthcoming, he may be required to examine the wife, in order to find confirmation of the alleged impotency of the husband. This course seems to have been pursued in a suit of nullity referred to by Mr. Chitty. A certificate was produced twelve years after the marriage, to the effect that the wife was *virgo intacta,* although *apta viro;* and this, coupled with two several confessions by the husband of his incapacity, and with proof that the woman's health had suffered, though the husband had not

given in his answer, and that he had removed into France, and had refused to undergo surgical examination, was holden sufficient in the ecclesiastical court.

It appears, then, that in suits of nullity of marriage the medical man will have to examine, not merely into the fact of impotence, but to determine whether or not it existed at the period of the marriage, and whether or not it admits of remedy.

This subject of impotence will have to be considered under the two heads of—1. Impotence in the *Male*, and 2. Impotence in the *Female*.

1. IMPOTENCE IN THE MALE.

The causes of impotence may be divided into two classes—1. *Physical*, and 2. *Moral* or *Mental*.

1. The *Physical Causes of Impotence* are—*a*. Too tender or too advanced an Age. *b*. Malformation or defect of the penis. *c*. Defect or disease of the testicles. *d*. Constitutional disease or debility.

a. *Age*.—The earliest age recognized by law for the formation of the marriage contract is 14 in the male, and 12 in the female. "But the ecclesiastical courts look rather to the habit, strength, and constitution of the parties; they only inquire whether they be *habiles ad matrimonium*, and not how many years they may have numbered; and, indeed, the common law will hold infantile marriages, solemnized with due formality, valid, when the parties on reaching the ages just stated do not demur to the contract."

The age at which puberty occurs in the male, no less than in the female, is subject to very great variation. It is usual to recognize 14 years of age as the earliest advent of puberty in the male; but the signs of puberty may first show themselves much later than this; and many examples of large development of the sexual organs in childhood are on record. The signs of puberty are to be sought for in the general conformation of the body, the character of the voice, the growth of hair on the pubes, and the development of the organs of generation themselves. If the genital organs are found to have the usual manly development, there is a presumption in favour of the seminal secretion having the elements necessary to impregnation.

But impotence may arise from the infirmity of age as well as from immaturity; and the question arises, At what age do the powers of procreation cease?

This question has acquired an unusual interest in consequence of the celebrated Banbury Peerage Case, which was brought before the House of Lords, and decided in the year 1813. The principal argument urged against the claimant was, that the ancestor under whom he claimed could not have been the son of Lord Banbury, because that nobleman was eighty years old when the child was born. In reference to this question of age, Sir Samuel Romilly expressed himself as follows: "The objection to the age of Lord Banbury may at

once be dismissed. The law of England admits of no age at which a man may not become a father; and many medical authorities may be cited to show that this rule is founded on reason. Dr. Gregory, of Edinburgh, whose name must be familiar to all admirers of science, says upon this subject,—'Magna autem de his rebus differentia; decantantur enim exempla senum in castris Veneris strenue merentium, postquam centum annos compleverant; neque sane dubium, aut adeo rarum octogenarium patrem fieri.' Haller likewise pronounces a man of ninety to be capable of procreating. Parr became a father in his one hundred and fortieth year. In short, the liberality of the law on this subject is excessive; for there is no age, from seven upwards, at which a man is denied the privilege of having children." Lord Erskine, following on the same side, cited the case of Sir Stephen Fox, who married at the age of seventy-seven, and had four children; the first child was born when the father was seventy-eight, the second and third were twins in the following year, and the fourth was born when the father was eighty-one. The Attorney-General, Sir Vicary Gibbs, who opposed the claimant's title, evidently felt the objection on the score of age to be far from valid, for he shifts his argument as rapidly as possible from it to more secure ground. He says: "Age may not be a proof of impotency, but it is evidence of it. The probability of the earl's begetting a child at eighty is very slight, and it is not increased by the appearance of another child two years later. Instances have been adduced of these extraordinary births, but none have been cited in which a man at eighty-two, having begotten a son, had concealed the birth of such son." With regard to age, then, it is clear that no limit is fixed by law, or can be assigned by science, at which the power of procreation ceases. Old age, provided it be a robust old age, is obviously no impediment to procreation. In the case of Lord Banbury, there is ample evidence of his having been capable of strong exercise until within a short period of his death.*

b. Malformation or defect of the penis.—The experiments of Spallanzani and Rossi have shown that in animals complete sexual intercourse is not necessary to impregnation; but that the injection of semen by a syringe will suffice for that purpose, the animal being in heat. John Hunter's ingenious expedient, recommended in a case of fistula in perineo, further proves that in the human subject the semen may be introduced in the same manner during the existence of the venereal orgasm with the same result. But the cases to be cited under the head of Pregnancy must be admitted to prove more than this. They show that a female may become pregnant in consequence of intercourse taking place in a state of unconsciousness, and accompanied by so little injury to the parts of generation as to attract no attention afterwards. Cases of pregnancy occurring in women in whom the hymen is intact may also be adduced in confirmation of the same view. So that it would seem

* See Sir Harris Nicolas's treatise on the Law of Adulterine Bastardy.

that neither the introduction of the male organ nor the venereal orgasm, are necessary to impregnation. It follows, then, from these considerations, that small size or partial mutilation of the penis is not to be accounted a cause of impotence. Provided that what exists or remains of the penis is sufficiently large to admit of introduction within the orifice of the vagina, and there be no impediment to the emission of semen, fruitful intercourse may take place. Thus, the removal of the glans penis; of the corpora cavernosa (as in a case quoted by Paris, from Piazzoni); of a very considerable portion of the organ (as in the case of a soldier quoted by Frank, in whom a large part of the penis was carried away by a musket-ball); did not occasion impotence. A still more extreme case is on record,* in which, in consequence of disease followed by amputation, there was only a very small protrusion of the organ on pressure, and yet the patient after the amputation became the father of two children. An amputation of the penis close to its root would in all probability cause impotence, though, for the reasons already assigned, fruitful intercourse is perhaps not altogether impossible.

The opposite malformation, viz., an excessive development of the penis, whether normal or as a consequence of disease, can also scarcely be regarded as a cause of impotence; for though intercourse, in the ordinary sense of the term, were impossible, still impregnation might take place.

The same remark applies with equal force to a malformation of the penis, in which the urethra opens upon the organ itself, though not in the usual situation.

Several such cases not resulting in impotence have been placed on record, and are the more conclusive, inasmuch as the malformation was transmitted from parent to child, and in one instance, reported by Frank, through three generations.

When the opening of the urethra, instead of being upon the penis, is in the perineum, fruitful sexual intercourse cannot take place unless the semen be artificially introduced into the vagina, as in the case of fistula in perineo just referred to. As in all cases of this class, it is possible that, either intentionally or accidentally, semen ejected from an opening remote from the penis may be introduced into the vagina, and thus cause impregnation, it would be unsafe to pronounce any person subject to such malformation to be incapable of fruitful sexual intercourse.

Persons subject to the malformations described at pages 18 and 19 under the names of *hypospadia* and *epispadia*, must also be accounted impotent, unless artificial means be resorted to.†

Congenital phymosis, and a confinement of the penis to the scrotum by a peculiar formation of the integuments, have also been mentioned among the causes of impotence; but both these malformations admit

* Mr. Hurd in 'London Med. and Surg. Journal,' vol. iv.
† 'Ed. Med. and Surg. Journal,' vol. i. pp. 43, 132.

of cure. Severe strictures, and extensive disease of the prostate gland, which act by preventing the expulsion of the semen, and paralysis of the muscles of the penis, complete the list of the causes of impotence which have their seat in the penis.

c. *Defect or Disease of the Testicles.*—The excision of both testicles early in life occasions impotence; but when they are removed after puberty, the power of complete sexual intercourse may continue for a time, and a person so mutilated may even become a father, through the semen contained in the vesiculæ seminales. That sexual intercourse may take place for a considerable period after the removal of both testicles is proved by a case related by Sir Astley Cooper.* For about twelve months after the loss of the second testicle there were emissions in coitu; after that period coitus took place at distant intervals, but without emission. Sexual intercourse becoming less and less frequent, ceased entirely at the end of ten years. The possibility of fruitful sexual intercourse taking place after castration, rests upon the discovery of apparently good semen in the vesiculæ seminales at a considerable interval after the removal of the testicles, as in a case cited by Otto; on the analogy of animals; and on at least one instance in the human subject. Sedillot cites a case on the authority of Boyer, in which, after the removal of both testicles, a man became a father.†

There has been much unnecessary discussion as to the possibility of a man having only one testicle being capable of fruitful intercourse, and as to the impotence of men in whom the testicles have not yet descended. As impregnation cannot be supposed to depend upon the quantity of semen introduced into the vagina, we may safely affirm that one sound testicle is to the full as efficient as two; and as the position of the testicles cannot be supposed to alter their functions, it is unnecessary to inquire whether men in whom the testicles are situate in the abdomen or in the inguinal canal are capable of procreating their species. If healthy and well-formed testicles can be discovered either in the scrotum or in the groin, we may safely decide that the parties are not impotent. If the testicles are to be found neither in the groin nor in the scrotum, our opinion must be founded on the sound of the voice, the growth of the hair, the development of the penis, and the general appearance of the body.

The question of impotence has sometimes been raised in cases in which the testicles are unusually small. This circumstance is not in itself a sufficient ground for inferring impotence; for though cases are on record in which a small size of the testicles coincided with a total absence of sexual desire, a case recorded by Mr. Wilson, shows that a person in whom both the penis and testicles are originally of very small size may have sexual desires, may experience erections with emissions, and may become a father of a family; those parts which were so small gradually increasing till they attain the size usual in

* 'Med. Chir. Rev.,' vol. xviii. p. 390.

† Sedillot's 'Manual,' p. 17.

the adult.* The sufficiency of even a single testicle of small size is shown by the case of John Bury, which occurred in the reign of Queen Elizabeth. His first wife, Willimet, alleged that he was impotent; and it appeared on the inspection of two physicians, that he had but one testicle of the size of a small bean, and that she was a virgin. On this and other circumstantial evidence, the ecclesiastical court annulled the marriage. But John Bury took a second wife, by whom he had a son. The legitimacy of this son being called in question, the common lawyers were unanimously of opinion that the ecclesiastical court had been misled, and pronounced the first marriage valid notwithstanding.†

Of the *diseases* which affect the testicles, and occasion impotence, the wasting of those organs which sometimes follows on attacks of cynanche parotidea is the most important. Foderé witnessed several cases of this kind in deserters condemned to labour on the canal at Arles; and Larrey, in many soldiers of the army of Egypt. The testes lose their sensibility, become soft, and diminish in size until they are no larger than a white French bean. When both testes are affected, the patient becomes impotent—the beard grows thin, and the intellect weak. Larrey states that the disease could not be traced to previous attacks of gonorrhœa, but attributes it to the use of the brandy of dates.

Elephantiasis is another alleged cause of degeneration of the testicle leading to impotence, and malignant diseases of the testicle, such as scirrhus and medullary sarcoma. may lead to the same result; but we cannot safely pronounce the subjects of these diseases to be impotent unless the entire structure of both testicles is affected.

Congenital scrotal hernia, or inguinal hernia of long standing, or other tumours of large size involving the genital organs, or occupying the lower part of the abdomen or upper part of the thighs, may occasion impotence by rendering sexual intercourse impossible.

d. Constitutional disease or debility.—Diseases which occasion extreme debility may become causes of impotence (temporary or permanent), through the weakness to which they give rise. There must always, however, be great difficulty in determining on the degree of debility or exhaustion from disease which entails impotence; and the same remark applies with equal force to the weakness brought on by age and natural decay.

But the diseases most likely to occasion impotence are those which affect the nervous centres, more especially diseases of the spine, whether arising from internal causes or from mechanical injury. Hemiplegia, from disease of the brain, and paraplegia, from disease or injury of the spinal cord, might be supposed to give rise to impotence; but that fruitful sexual intercourse may take place within a few weeks of a well-marked attack of hemiplegia is proved by the cases

* 'Lectures on the Urinary and Genital Organs,' p. 424.
† Hargrave's 'State Trials,' Appendix, vol. x. p. 24.

adduced on the occasion of the trial of Legge *v.* Edmonds. After partial recovery from paraplegia, also, the power of fruitful sexual intercourse does not appear to be lost.*

Case of Legge v. *Edmonds*.—The following is a careful summary of those facts of this case which are interesting in a medico-legal point of view. Mr. Legge, of Newent, married August 25, 1835, and died June 24, 1844. His wife was delivered of a daughter March 23, 1837, and again of a daughter October 30, 1844, being four months after the death of Mr. Legge. The first child attained the age of two years; the second survived four years. The legitimacy of the second child was called in question, partly on account of the state of health of Mr. Legge at the date of the conception, and partly in consequence of the alleged adultery of Mrs. Legge with the defendant, to whom she was subsequently married, and by whom she had children. Mr. Legge was an athletic man, and a free liver, occasionally drinking to excess, but not an habitual drunkard. On November 4th, 1843, when about thirty-five or thirty-six years of age, he had a well-marked apoplectic seizure, with loss of speech and hemiplegia of the right side, for which he was actively treated, and was so far recovered by November 27th, being little more than three weeks from the date of the attack, as to cease to take medicine. The hired nurse left him at the end of five weeks. After the lapse of a week his speech was partially restored; he left his bed at the end of a fortnight; came down stairs as early as the end of the third week; by the end of the fourth week he was walking in the town, and drank tea out. At or about this period he was seen walking about by more than one witness. On December 7th (little more than a month after the attack), he went to Ledbury in a gig, driving himself part of the way, and signed his name at the bank, taking his hand out of a sling for the purpose. On December 27th he transacted business as usual, and wrote his name. He dined out near Newent before Christmas-day, and rode on horseback before the end of the year. On January 6th he visited Gloucester, and had transactions with several tradesmen. Before the end of January he supped at Gloucester, and opened oysters, and on the 31st of the month attended a meeting, at which he took off his coat and challenged one of the company to fight. Evidence of the most conclusive kind was brought forward to prove that between the end of November, 1843, and the end of January, 1844, he had repeatedly transacted business and written his name, walked about without support, driven himself in a gig, ridden on horseback and leaped hurdles, gone out shooting, and killed game. It is also proved by the testimony of several witnesses that he had so far recovered before the end of January as to seem to be in perfect health. He had no new attack of illness till February 28th. The cause of his death in the June following seems to have been disease of the liver and dropsy, attended by a general break up of the system.

* See a case quoted from M. Brachet by Curling on 'Diseases of the Testes,' 2nd edit. p. 371.

From the foregoing statement, carefully compiled from the notes of Mr. Charles Jones, the solicitor for the defence, it appears that there were no medical grounds for assuming an incapacity for fruitful sexual intercourse at the end of January, the presumed date of the conception of the daughter whose legitimacy was contested. The adverse opinion of Drs. Taylor and Carpenter was based upon other than medical considerations. The inquiry, commenced at Cheltenham, was afterwards continued in London, when, in addition to a confirmation of the opinion previously expressed by Dr. Semple, Mr. Walsh, and the author, by Drs. Frederic Bird and Blundell, the following facts were given in evidence:—1. E. K., in his fifty-eighth year, when æt. thirty-three, had a well-marked attack of hemiplegia of the right side, which has left him lame, and with his speech slightly affected. He alleges that he had connection with his wife within a week of his seizure, that his sexual powers have not been impaired, and that since the attack he has had three children always considered as his own. His wife gives three weeks as the extreme limit of time after the attack at which connection took place. The facts of this case were confirmed by Mr. Wetherfield, of Covent Garden, who added that he had known other cases of hemiplegic patients begetting children. 2. W. D., æt. thirty-two, had an attack of hemiplegia of the right side when only twenty-six years of age, and a second attack when twenty-eight years old. Intercourse took place within a fortnight of the first attack; and there have been three children, of which the first was born in about eighteen months from the first seizure. Neither husband nor wife had any doubt that the children were their own.

In both these instances the recovery was less complete than in the case of Mr. Legge. The reader will find a full account of this case, differing in some material points from the preceding, in Taylor's 'Medical Jurisprudence,' sixth edition, p. 675. The cases of E. K. and W. D. are not comprised in his review of the case.

There are certain drugs, again, which taken in single large doses, or used habitually in excess for considerable periods of time, may give rise to impotence. Opium, spirituous liquors, and tobacco, and other substances of less power, such as camphor, coffee, and nitre, have been mentioned as causing impotence, but with what justice it is difficult to say.

Masturbation and early and excessive sexual indulgence are also among the acknowledged causes of impotence.

2. *Moral or Mental Causes of Impotence.*—Excessive passion, timidity, apprehension, superstition, fear, aversion, and disgust, have been known to occasion impotence. With the exception of the last-named emotions—aversion and disgust—the remainder are transitory, and curable. That impotence with one female is not inconsistent with sexual ability in respect of others is proved by the case of John Bury, already referred to, as well as by that of the Earl of Essex, who

admitted his inability to know the Countess of Essex, but denied his impotence as to other females.*

2. IMPOTENCE IN THE FEMALE.

The causes which prevent sexual intercourse in the female are, 1.—*Narrowness of the vagina*, existing in all subjects before the age of puberty; and in rare instances in the full-grown adult. In the latter, this defect admits of remedy by the continued use of emollients, and by careful dilatation.

2. *Adhesion of the labia*, the result of inflammation; and obliteration of the vagina from the same cause.

3. *Absence of the vagina*, accompanied in some cases by absence of the uterus.

4. *Imperforate hymen.* As this impediment may be removed by the knife, it belongs to the class of curable causes.

5. *Tumours occupying the vagina*, such as polypi, scirrhous formations, prolapsus uteri, and prolapsus vesicæ.

In addition to these mechanical causes of impotence, there are others which, without positively preventing sexual intercourse, render it so difficult or painful, that they deserve mention in connection with the subject of impotence. Of these the more important are—Unusual shortness of the vagina; inflammatory or malignant diseases of the vagina or uterus; extreme sensibility of the parts; a fistulous communication between the vagina and rectum; and internal piles. Some of these are obviously curable, others admit of no relief.

Sterility.—Those permanent causes of sterility which are not at the same time causes of impotence (such as absence of the uterus, the rest of the genital organs being well formed, and closure of the Fallopian tubes, or of the neck of the uterus), are for the most part of such a character as not to be discoverable during life. Besides these, there are curable causes of sterility, as of impotence, such as profuse discharges, menorrhagia and leucorrhœa, and alterations in the character of the secretions of the vagina and uterus.† There are also other causes of sterility little understood, as is proved by the possibility of females sterile with one husband becoming fruitful with another. Promiscuous intercourse is one of the acknowledged causes of sterility; but it is of a temporary nature, as is shown by the fruitfulness of married convicts who had been previously prostitutes.

The subject of sterility is of little importance in a medico-legal point of view, as the question of sterility, apart from that of impotence, is very unlikely to be mooted in a court of law.

A few directions as to the mode of conducting examinations in cases of alleged impotence will conclude this subject.

* See Hargrave's 'State Trials,' vol. i. p. 315; or abstract by Beck, p. 54.

† M. Donné has shown that these secretions, in females apparently in good health, are sometimes such as instantly to destroy the seminal animalcules.

1. Note the age, general appearance, habit of body, and state of health, of the person complained of, and ascertain what diseases he or she may have previously laboured under.

2. The sexual parts should be carefully examined, and their degree of development ascertained. The nature and extent of such canals as may be discovered, and the parts with which they communicate, should be ascertained by the sound or catheter. The urethra of the male should be explored, and the state of the prostate ascertained.

3. No manipulations of a gross or indelicate kind should be practised, as they are both unnecessary and inconclusive; and no artificial stimulus should be employed; though the use of cantharides and other provocatives has been recommended on high authority.

4. These examinations can only be safely intrusted to skilful and experienced medical men. The examination of females should be conducted by accoucheurs. The jury of matrons is now justly regarded as incompetent.

RAPE.

Rape was formerly punished as a capital offence, as was the carnal knowledge of a female under ten years of age. The carnal knowledge of a female between ten and twelve years was punished by imprisonment, with or without hard labour.

The statute, 4th and 5th Vict., chap. 56, substitutes transportation for life for the punishment of death; but leaves the subject in other respects in much the same state as before.

The legal definition of a rape is, " the carnal knowledge of a woman forcibly and against her will."

As the law makes no distinction between the married and the single, the chaste and the unchaste, and as it does not limit the time after the alleged commission of the offence at which an accusation may be preferred, the medical man may have to make his examination of the female under very different circumstances in different cases.

Rape being defined as " the *carnal knowledge* of a woman forcibly and against her will," a question has arisen as to the meaning of the term *carnal knowledge*, and a doubt has been raised whether it implies penetration and emission, or penetration only. Though this difficulty might be supposed to have been set at rest by the 9th of Geo. IV., chap. 31, which distinctly provides that neither in cases of rape, nor in offences *contra naturam*, shall it be necessary to prove the actual emission of seed; but that the carnal knowledge shall be deemed complete upon proof of penetration only, much difference of opinion continued to exist among legal writers, and conflicting decisions were given from the bench, till at length it came to be understood and universally admitted that proof of emission is not required. A question was next raised as to the meaning of the word " penetration," and it

was at length decided, after further difference of legal opinions and decisions, that any introduction of the male organ within the vulva constitutes penetration.*

The least possible introduction, then, of the male organ within the vulva, even short of the rupture of the hymen, and without the emission of semen, constitutes a rape, provided it be done forcibly and against the will of the female.

In order, therefore, to obtain a conviction in a case of alleged rape, it is necessary to prove, 1, Forcible penetration, in this limited sense of the term; and, 2. In the case of females above twelve years of age, that the force was used against the will of the complainant. The subject, therefore, divides itself into two parts—the question of penetration, or, in other words, the *physical signs* of rape, and the question of consent. On the first question the medical man is required to give evidence; on the second the court decides on the evidence of other witnesses.

PHYSICAL SIGNS OF RAPE.

Though, after the explanation already given of the meaning of the term penetration, it is not necessary to prove the existence of any definite amount of injury (as, for instance, the rupture of the hymen in those who have not had previous sexual intercourse), it is incumbent on the medical man to make a minute and careful examination of the parts of generation, so as to be able to give a clear description of the amount of injury they have sustained. And though it is not necessary to prove the fact of emission, the discovery of semen on the person of the female, or on her dress, must obviously be of very great importance.

The duty of the medical man when called on to examine the person of a female said to have been violated will therefore consist—1. In an examination of the parts of generation, with a view to an exact description of the amount of injury they have sustained. 2. In an examination of the body and limbs of the female, with a view to discover bruises, scratches, or other evidences of resistance to the alleged violence. 3. In an examination of the linen worn by the female at the time of the alleged rape, with a view to the discovery of spots of semen or of blood, and, in some cases, of other discharges. It may also be necessary to examine the person and linen of the accused.

1. *Examination of the parts of generation.*—Before proceeding to consider the injuries which these parts may sustain in cases of rape, it will be necessary to institute a preliminary inquiry respecting the value of the hymen, and of other alleged signs of virginity; for, in the greater number of instances, the crime of rape is committed on the person of a female who has not previously had sexual intercourse; and it is usual,

* See the cases quoted in Archbold's 'Pleading and Evidence in Criminal Cases,' and in the first edition of this work.

in the case of adult females, to endeavour to rebut the charge of rape by alleging previous unchastity—a question on which the medical examiner may be required to express an opinion.

The Hymen.—Strange as it may appear, there has been much difference of opinion among authors as to the very existence of this membrane. Male, Beck, and Devergie, give long lists of those who affirm and of those who deny its existence; but it must be admitted that the former have the advantage, both in numbers and authority.

Orfila examined more than 200 subjects, and never found it wanting. Gavard found it in the fœtus, in the new-born infant, in young women from 23 to 25 years of age, and in one of 50 years old. Bennach, of Marseilles, saw it in a woman of 60. Devergie himself has found it invariably present in new-born infants, and has met with it in women of different ages exposed at the Morgue, of whom one was 65 and another 72 years old. The same author has twice observed the labia minora united through the whole extent of their free edge, leaving above a small aperture corresponding to the meatus urinarius. In another case the vagina was closed by a false membrane within the labia minora, having a perfect hymen behind it. Devergie concludes, from a careful review of all his authorities, that the hymen is an almost constant formation, recognizable by marked characters in 99 cases out of 100; and that the differences of opinion which have existed in former times have arisen from the great varieties discoverable in its form and size.*

The most usual form of the hymen is that of a semilunar fold, concave before and convex behind, bounding the entrance of the vagina below, the extremities losing themselves behind the labia minora in the circumference of the aperture of the vagina. Another form is that of a circular membrane, perforated in the centre, and adhering by its entire circumference to the opening of the vagina. A third form consists of a membrane filling up the entire orifice of the vagina, with the exception of a small opening above, corresponding to the meatus urinarius. Lastly, the most unusual form is that of filaments of mucous membrane uniting the carunculæ myrtiformes.

At birth the hymen is limited in extent; but little by little, and especially during the period which precedes puberty, it increases in size. Its free edge then becomes relaxed and thrown into folds, and it is believed that when the rupture takes place it is chiefly in these folds, and that in this way those small pyramidal tubercles, three, four, five, or six in number, known as the carunculæ myrtiformes, are formed. These small bodies, being the remains of the hymen, are looked upon as evidence of the previous existence of that membrane.

There can be little doubt, then, of the existence of the hymen, in the great majority of females in some one of the forms just described. The medical examiner should, therefore, ascertain whether it is present

* Consult Devergie, 'Des Attentats à la Pudeur.'

or absent. Its recent destruction affords conclusive evidence of the recent employment of force, and if there are other marks of violence on the parts of generation and on the person of the female, there can be no reasonable doubt of the commission of a rape, as far as that crime admits of being proved by physical signs.

But the medical examiner, in place of the hymen, may find only the carunculæ myrtiformes, resulting from the destruction of the membrane at some earlier period. Would this ascertained absence of the hymen justify the assertion that the female had had previous sexual intercourse? The answer to this question is obvious. The hymen may be destroyed otherwise than by sexual intercourse: from within, if the aperture be small, by the first menstrual flux, or by the accumulation of other discharges; from without, by accident, or by the intentional introduction of foreign bodies for lascivious purposes. The membrane may also be destroyed by disease; or it may be originally wanting, as in a case related by Capuron. The absence of the hymen, therefore, is no proof that a female has had previous sexual intercourse.

On the other hand, the presence of the hymen must not be accounted a certain sign of chastity; for after sexual intercourse the membrane has remained intact, and even after the birth of children. Ambrose Paré, Ruisch, Capuron, and Baudelocque give cases of mothers in whom the membrane was either ruptured by the child, or purposely divided by the knife; and Tolberg, on the authority of the elder Meckel, cites the case of a woman in whom the hymen was preserved circular and tense after the birth of a fœtus of five months, enveloped in all its membranes.

This occasional persistence of the hymen in married and pregnant females will occasion less surprise if we bear in mind the very great difference which exists in the size of the parts of generation in different females, and the effect of habitual discharges in causing a relaxed state of the parts.

The presence of the hymen, then, is not conclusive proof of chastity, nor its absence of the reverse.

Besides the intact condition of the hymen, or its recent rupture, other signs of virginity have been enumerated of which the most important are the fresh colour, firmness, and elasticity of the labia, the entire state of the fourchette, the narrowness and rugose state of the vagina, and a plump and elastic condition of the breasts. The difficulty and pain attending intercourse, and the flow of blood, have also been mentioned as signs of previous virginity. All these signs are fallacious. The condition of the labia just described is not always destroyed by repeated acts of intercourse, and in the state of the breasts many widows and mothers may compare with undoubted virgins. The fourchette may remain unruptured after repeated intercourse, and even after child-bearing; and the narrow and constricted state of the vagina is not only not peculiar to virgins, but it may be

artificially imitated by the use of astringents, whilst the opposite state is naturally present during the menstrual period, and may be induced by the leucorrhœal discharge, or by profuse menstruation. The pain attending a first connection, and the show of blood, are still more fallacious, as both may occur from relative disproportion.

The difficulty of ascertaining the fact of previous sexual intercourse, and the possibility of the usual signs of virginity remaining after long habits of unchastity, is well illustrated by the following case.*

"Several years ago, two young women of genteel appearance were attacked in the public streets by some young men, who called them gross and opprobrious names, and told the passers-by that they were nothing better than common prostitutes. Some good-natured persons resented this conduct, and took the girls' part. A complaint was lodged on their behalf against their defamers, and the latter were summoned to appear before a magistrate. The defendants pleaded a justification, while the females, on the contrary, stoutly insisted on their purity; they even offered to submit to a personal inspection by a medical examiner,—which the opposite party dared them to do. A sworn inspector, a clever and conscientious man, was appointed by the magistrate, and the result of his investigation was this,—That it was totally out of his power to say anything certain in regard to one of the females; she might or she might not be a virgin; but for the other, she *probably* had had some intercourse with men, but he could not assert the fact positively. The issue of the dispute I know not; but this is certain, that it subsequently came out that these same young women had actually been for some time entered on the registers of the police, and one proof of their being anything but virgins was, that they had both been, on several occasions, affected with the venereal disease."

The physical signs of rape consist in marks of violence on the organs of generation, proportioned to the force employed, the resistance offered, and the relative disproportion of the parts. If the sufferer has not previously had sexual intercourse, there may be, in addition to marks of injury on the labia, rupture of the hymen and fourchette. If the injury be recent, the parts will be found lacerated, abraded, and covered with blood; if of some standing, there will be signs of recent inflammation, with increased heat and swelling of the genitals, and profuse mucous discharge, at first tinged with blood.

These appearances will present themselves if the parts are inspected soon after the commission of the crime; but at the end of three or four days the inflammation will have subsided, the parts may be entirely healed, and nothing may remain to point out the injury which has been inflicted.

In women who have had sexual intercourse, and in those who have borne children, the marks of violence will be, *cæteris paribus*, less

* Parent Duchatelet, 'La Prostitution dans la Ville de Paris.'

distinct, and the resulting inflammation less intense. The marks of injury would also be less distinct if the offence were committed during the menstrual period, when the parts are dilated and relaxed, or in the case of a woman suffering from any profuse discharge.

It is scarcely necessary to state that all these marks of injury to the parts of generation may exist, and yet no rape have been committed; for a first intercourse, with full consent, would give rise to the same appearances, as would a great disproportion of parts in the case of a woman accustomed to sexual intercourse.

The possibility of marks of injury to the organs of generation being self-inflicted, or otherwise fraudulently produced, in order to support a charge of rape, must also be borne in mind. In a case related by Foderé an appearance of injury to the parts of generation of a child was produced by the pressure of a piece of money.

Appearances on the parts of generation, similar to those due to violence, may also be occasioned by disease. We owe our first knowledge of this important fact to Dr. Percival. "Jane Hampson, æt. 4, was admitted an out-patient of the Manchester Infirmary, February 11, 1791. The parts of generation were highly inflamed, sore, and painful; and it was stated by the mother, that the child had been as well as usual till the preceding day, when she complained of pain in making water. This induced the mother to examine the parts affected, when she was surprised to find the appearances above described. The child had slept two or three nights in the same bed with a boy fourteen years old, and had complained of being very much hurt by him during the night. Leeches and other external applications, together with appropriate internal remedies were prescribed; but the debility increased, and on the 20th of February the child died. A coroner's inquest was held; previous to which the body was inspected, and the abdominal and thoracic viscera found free from disease. From these circumstances, Mr. Ward, the surgeon attending the case, was induced to give it as his opinion that the child's death was caused by external violence; and a verdict of murder was accordingly returned against the boy with whom she had slept. Not many weeks elapsed, however, before several similar cases occurred, in which there was no reason to suspect that external violence had been offered, and some in which it was absolutely certain that no such injury could have taken place. A few of these patients died. Mr. Ward was now convinced that he was under a mistake in attributing the death of Jane Hampson to external violence, and informed the coroner of the reasons which induced this change of opinion. Accordingly, when the boy was called to the bar at Lancaster, the judge informed the jury that the evidence adduced was not sufficient to convict; that it would give rise to much indelicate discussion if they proceeded to the trial, and that he hoped, therefore, they would acquit him without calling witnesses. With this request the jury immediately complied. The

disorder in these cases, says Dr. Percival, had been a typhus fever, accompanied with a mortification of the pudenda."*

A complaint nearly resembling that observed by Dr. Percival has been described by Mr. Kinder Wood. It is preceded by all the ordinary symptoms of fever for about three days. The attention of parents is then called to the seat of the disease, by complaints in voiding the urine. When the genital organs are examined, one or both labia are found enlarged and inflamed. The inflammation is of a dark tint, and soon extends internally over the clitoris, nymphæ, and hymen. Ulceration succeeds, and the external organs of generation are progressively destroyed. The affection proved very fatal. It seemed to be a peculiar kind of eruptive fever.†

Mr. Lawrence ‡ also describes a peculiar kind of inflammation incidental to the external organs of children, which is not only a serious affection in itself, but has often been confounded with syphilitic affections, so as to give rise to the suspicion that the children had been ill-used, and had thus caught the disease. In some instances judicial trials of a serious nature have been the result. It occurs in young subjects of from four or five to eight or ten years of age: it consists of inflammation of the labia and the external organs generally; which assume a deep, dusky red colour, and in which foul ulcerations form with a tawny gray, and sometimes an actual sloughing surface. They are very painful, attended with a thin fetid discharge, and sometimes extend so as to occupy a considerable portion of the surface of the external organs of generation, with feverishness, restlessness, great pain, and very considerable disturbance of the health of the child. This disease differs widely from syphilis. It commences with "an excessively deep-coloured inflammation," with great disturbance of the health, the inflammation being followed by foul and sloughing ulcers, "of a tawny colour, totally different from the characters of any primary venereal sore." Mr. Lawrence gives the case of a child suffering from this affection, who, in consequence of previous professional opinions that it was the venereal disease, was questioned and interrogated until she gave in to the idea that had been suggested and strongly entertained by the parents, and said that a certain youth had done something or other to her. The suspected individual was taken to Bow Street, examined there, and tried at the Old Bailey on a capital charge of violating this young person: on that trial Mr. Lawrence gave evidence, and he states that this is not the only instance in which a circumstance of this kind has taken place.

Mr. Wilde of Dublin describes a similar affection of the parts of generation of young children in connection with leucorrhœal ophthalmia, and he adduces facts to prove that both affections are con-

* 'Medical Ethics,' pp. 103 and 231.

† 'Med. Chir. Trans.,' vol. viii. p. 84. See also Beck's 'Medical Jurisprudence,' art. Rape, for further references to authors.

‡ Surgical Lectures, 'Lancet.'

tagious. (See 'Medical Times and Gazette,' Jan. 17, 1857. See also Mr. Kesteven in same journal, April, 1859.)

I have seen several cases of this deep-coloured inflammation of the genitals with profuse discharge, but not proceeding to ulceration; and have generally found the friends suspicious of violence.

It appears, then, that *disease* may give rise to appearances on the parts of generation closely resembling the effects of violence. But it is important to bear in mind, that such disease attacks only young children, and that in some instances the same disorder prevails at the same time, in the same place.

2. The evidence afforded by the discovery of marks of violence on the parts of generation may derive important confirmation from the results of an examination of the person of the female. If great violence has been used, and much resistance offered, the traces of the struggle will be found in the shape of bruises and scratches, especially on the groins, thighs, and knees, and on the arms and chest. The clothes may also be torn in the struggle.

Marks of violence, then, on the parts of generation, corroborated by bruises and scratches on other parts of the person, form the principal physical signs of rape.

3. *Examination of the linen.*—Very important information may be derived from a careful examination of the linen worn by the female at the time of the alleged rape. Such an examination may furnish valuable negative evidence, or it may issue in the discovery of spots or stains of blood, of menstrual fluid, of semen, or of other discharges.

Spots of blood.—When the injury is recent, we shall expect to find spots of pure blood on the linen; spots presenting a uniform red colour throughout. When the injury has been some little time inflicted, and the first hæmorrhage has ceased, there will be a muco-sanguinolent discharge, which will stain the linen less deeply and uniformly, presenting spots of a lighter colour, reddish, or of a yellowish red, lighter in the centre, and bounded at the circumference by a circle of a deeper colour than the rest of the spot.

The coexistence of these spots of blood, or of bloody mucus, with marks of violence, forms a strong corroboration of a charge of rape; but the absence of marks of violence would justify a suspicion of fraud.

For the chemical tests and microscopic characters of spots of blood, the reader is referred to the chapter on wounds.

The menstrual fluid.—It is necessary to be on our guard against confounding blood-stains with the stains produced by the menstrual discharge. The menstrual fluid is secreted by the lining membrane of the uterus. It resembles venous blood in colour, but it is not brightened by contact with the air; and it differs both from arterial and venous blood in containing a very small quantity of fibrine, and not being coagulable. It has a characteristic sour odour, and an acid reaction, due to the presence of free phosphoric and lactic acids. It is also blended with mucus and epithelial scales; and is sometimes

discharged in union with clots of blood. These properties of the menstrual fluid are so well marked that there ought to be no difficulty in distinguishing it from blood when presented in any quantity in its pure unmixed state. But the appearances presented by spots or stains of menstrual fluid and blood respectively are not so distinct. A stain, as distinguished from an undisturbed spot of blood, may closely resemble a stain or spot due to the menstrual discharge. Should the examination in a case of rape be instituted soon after the commission of the offence, the presence of the menses might be ascertained by introducing a plug into the vagina. If the coloured fluid were found to flow from the upper part of the vagina, we should be justified in inferring that it was the menstrual fluid.

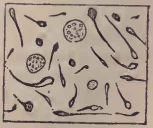
If the menses were flowing at the time of an alleged rape, blood would be mixed with the discharge. But this could give rise to no difficulty, as some of the stains, presenting all the characters of blood, would correspond with marks of violence on the parts of generation.

This coincidence took place in the case of Mary Ashford, which occurred in 1817, and excited much interest at the time.

In this case it was proved that the menses were flowing at the time of the alleged rape, and *coagulated* blood was found at the spot where connection took place, and in the middle of the impression of a figure on the grass. The parts of generation were lacerated, and covered with coagulated blood. The shirt and pantaloons of the accused were also bloody. Abraham Thornton, the accused, confessed the connection, but said that it was with consent. The dead body of Mary Ashford was found the next morning in a pool of water.*

Semen, and seminal spots.—When called upon to examine the person of a female soon after the violence has been committed, semen may sometimes be discovered at the orifice of the vagina, or on the other parts of generation. In other instances, we may find seminal spots on the garments of the female. If a fluid is found having the general appearance of semen, its real character may be determined by examination under the microscope, which reveals the presence of certain minute bodies of a very characteristic appearance, and variously designated as *spermatozoa*, *zoosperms*, *seminal animalcules*, and *cercaria seminis*. These bodies have been proved to exist in the semen of all male animals which have reached the age of puberty. When examined by a powerful glass they present the appearance depicted in the annexed woodcut. They consist of a slender filament surmounted by an oval or pear-shaped head. They are diffused through the semen in large numbers, mixed with granular or corpuscles of much larger size. They are very minute, their entire length not exceeding the 50th

Fig. 3.



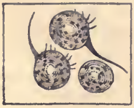
* See this case given at length in Cummin's Lectures, 'Med. Gaz.,' vol. xxi. p. 386.

of a line, and the head varying in width from the 600th to the 800th of a line; or about half the diameter of the human red blood-corpuscles. For several hours after the death of the animal to which they belong they are in motion, the filament having a peculiar lashing, undulating, or vibrating movement. But when they have ceased to move, they may still be detected by their peculiar shape. This shape they retain even when dry, and they may be discovered in dried semen if carefully moistened. Orfila discovered them in semen which had been kept for eighteen years on glass plates. These bodies also resist putrefaction in a remarkable degree, so that Dr. John Dewy observed them in putrid semen which had been kept for ten weeks.* They have also been repeatedly detected by several observers in the liquid obtained by steeping seminal stains on linen in a small quantity of distilled water. Devergie found them in stains which had been dried ten months, and M. Bayard discovered complete animalcules in seminal stains two months, a year, and even three years old.

An instructive case of rape, by Dr. Henry Munroe, accompanied by an engraving showing the spermatozoa, the blood globules, the epithelial scales of the menstrual discharge, and the mucous bodies in the liquid obtained by steeping the stains on linen in distilled water, will be found in Beale's 'Archives of Medicine,' vol. i. p. 139.

Till a recent period, these bodies were the only ones found on the person or on the linen of the female which possessed motion, or consisted of the two constituent parts—an oval head and a filamentous tail. But M. Donné has described and depicted an animalcule occasionally encountered in vaginal mucus, and especially in the discharges of females careless of personal cleanliness, to which he gives the name of Trichomonas vaginæ. It is found mixed with granular bodies of larger size than those of semen, and having the shape depicted in the annexed engraving. The head of the trichomonas is three times the size of that of the spermatozoa; it has several granules in its interior, and a row of from four to six short cilia springing from its circumference.

Fig. 4.



But besides the discovery of the seminal animalcules, there are other means of identifying seminal spots. They are of a grayish colour, which is best seen by placing the linen between the eye and the light. They are stiff, as if starched; inodorous, but when moistened give out the well-known seminal odour. Held near the fire—taking care at the same time not to scorch the linen—the spots become of a yellow fawn colour, and several small whitish spots, which were not previously perceived, make their appearance. According to Orfila, this effect of heat on the seminal spots is characteristic: it does not take place with any other healthy or morbid discharge; neither with the vaginal

* Ed. 'Med. and Surg. Journ.,' vol. iv. p. 15.

mucus and the lochia; nor with the gonorrhœal discharge and fluor albus.

Pure and concentrated nitric acid gives to the solution of the semen in water a slight yellowish tinge, though it were colourless before, but causes no precipitate.

The change of colour which the spot undergoes on being held near the fire, and the peculiar odour of the solution, are highly characteristic. The absence of precipitate with nitric acid is less conclusive. The discovery of perfect spermatozoa places the nature of the spot beyond doubt.*

Other discharges.—In addition to the physical signs of rape already mentioned, it sometimes happens that there are traces of the venereal disease, and a question may arise as to the value to be attached to the presence of that disease. As the earliest period after connection at which the disease occurs is about three days, if it should be present in a female examined soon after the alleged violence, the circumstance could have no influence on the decision of the case, except in as far as it would prove the female unchaste. If on an examination at a later period the disease should be found present, it would prove the female unchaste if the disease were absent in the accused, but would form a strong corroboration of the charge if present. As we have no means of distinguishing the discharge in gonorrhœa from the purulent or muco-purulent discharge from the vagina of children, or from the more highly coloured leucorrhœal discharges of the adult, it will be necessary to be very cautious in forming an opinion as to the nature of any existing discharge.

In cases of accusation of rape based upon the existence of a purulent or muco-purulent discharge in young females, the ascertained absence of gonorrhœa in the accused, coupled with evidence of the frequency of such discharges in children, is of the utmost importance to the defence.

The inferences drawn from an examination of the parts of generation and person of the female, and of the state of the linen, admit of being strengthened by an

Examination of the accused.—The person of the accused, if examined soon after the commission of the offence, may bear distinct marks of the resistance which was offered, and the linen worn at the time may be found soiled with blood and semen. In some instances, too, the force used is such as to rupture the frœnum. On the other hand, the result of the examination may be such as to negative the supposition of rape; for the accused may prove too weak, or of too tender, or too advanced an age to be justly chargeable with rape; or it may happen that he is impotent, in which case the charge must at once fall to the ground.

Some confirmation of the statements of the female may sometimes

* Orfila: 'Traité de Médecine Légale,' vol. i. pp. 156 et seq.

be derived from an inspection of the spot upon which the offence was alleged to have been committed. It may bear distinct traces of a struggle, and be found covered with blood.

In case of death following rape, a post-mortem examination may be required. No particular directions are necessary in this case. The parts of generation, and the surface of the body, would have to be carefully inspected; and the mouth should be especially examined, as foreign bodies are sometimes introduced in order to stop the cries of the female.

Though the medical examiner may be in a condition to prove, by an inspection of the persons of the complainant and of the accused, that an act of forcible sexual intercourse has taken place, the proof of rape may still be incomplete; for the female may have consented after offering a certain amount of resistance. The sufficiency of the resistance, and the question of consent generally, must be reserved for the jury, who will be guided by the following considerations:—The previous character of the female, and her relations with the accused; the motives by which she may be actuated in bringing the accusation; the place and circumstances in which the offence was alleged to have been committed; the time which elapsed before complaint was made; whether, if other persons were near at hand at the time of the alleged violence, her cries were heard; and whether, if they were discovered, she made resistance, and cried out before the discovery. The question of consent has of course no place in the case of children under ten years of age, of idiots, or of females in a state of unconsciousness, however produced.

This question of consent has sometimes been summarily answered in the case of the adult female, by alleging the utter impossibility of committing the crime on a female in full possession of her senses, and of an ordinary degree of strength. Of the difficulty of completing the offence, in the sense which was formerly attached to the term penetration, there can be little doubt, but as that term is now understood, the offence must be admitted to be possible, especially where there is great disparity of strength. The female, too, may faint from terror, or yield to threats of worse violence.

Two questions connected with this subject still remain to be discussed. 1. Can a female be violated during sleep without her knowledge? and, 2. Does pregnancy ever follow rape?

1. *Can a female be violated during sleep without her knowledge?*—That a female may be violated during *stupor* produced by narcotics, there is no doubt; that a female, accustomed to sexual intercourse, may be violated during profound sleep, is also highly probable;* but

* In the year 1840, I was consulted by a poor woman, who, after mentioning other complaints of little importance, stated that she was somewhat alarmed by the fact of her sleep being so heavy that she was with difficulty aroused. She added, by way of illustration, that her husband had assured her that he had frequently had connection with her during sleep.

that a virgin should be violated during sleep may be held to be in the very highest degree improbable. In the absence of facts this is all that can be said on the subject; but that it may be a matter of doubt, is proved by the fact that the medical faculty of Leipsic, in 1669, answered the question in the affirmative, and the juridical faculty of Jena, in the negative. Violation is here used in the sense of sexual connection accompanied by a certain degree of force: but when discussing the question of pregnancy, cases will be cited which go to prove the possibility of sexual intercourse which has taken place during sleep being followed by pregnancy, which event has come upon the female by surprise—a proof that connection was not accompanied by violence.

2. *Does pregnancy ever follow rape?*—The facts just referred to prove that pregnancy may follow unconscious connection, hence the venereal orgasm is not a *sine quâ non* of conception. It is also admitted that pregnancy may follow a first intercourse with consent; hence there is nothing in the nature of a first connection to prevent conception. It is, therefore, in the highest degree improbable that an event which may follow an act unconsciously performed, and in spite of the suffering attending a first intercourse, should be prevented by the repugnance which a female feels to the party offering her violence.

It now only remains to give some short directions for performing medico-legal examinations in cases of alleged rape.

1. Let no time be lost in making a personal inspection of the female, and let a note be taken of the time at which the inspection is made, and of that at which the offence is stated to have been committed.

2. Observe the age, strength, and state of health of the complainant; examine any injuries that may exist, or may be alleged to exist, on her person, and see whether they correspond with the cause by which they are said to have been inflicted.

3. Examine the organs of generation, noticing the exact state of the parts; whether they are bloody, swollen, inflamed, abraded, or ulcerated; whether there is any discharge, and from what part it flows; whether the hymen and fourchette are entire or injured, and if injured, whether recently, and whether the carunculæ myrtiformes are present; ascertain the date and origin of such marks of violence as exist, and determine whether they might not have been produced by other than the alleged cause, as, for instance, by foreign bodies, purposely applied to, or introduced into, the parts. Inquire, also, whether the alleged violation took place during the menstrual period, or while the female was labouring under any debilitating discharge.

4. Let any existing discharge be carefully observed, collected, and examined; and let any spots of blood or semen on the person or clothes be also reserved for examination.

5. If death have taken place, the body must be inspected, and search be made for bruises, fractures, or dislocations; and for foreign bodies thrust into the mouth. The internal viscera must also be examined.

6. Examine the spot on which the offence was committed.

Lastly. Examine the person of the accused; his bodily strength and development; the parts of generation, with a view to discover whether he be impotent, or capable of producing the existing amount of injury, whether he have the venereal disease, or any recent abrasion, or rupture of the frænum. Examine his person also, with a view to discover bruises, scratches, or other marks of resistance; and his linen for spots of blood or semen.

If the joint examination of the complainant and accused does not support the charge of rape, it may justify a charge of assault with intent to commit it; and it is usual, when the capital charge fails, for another indictment to be preferred, charging the prisoner with the misdemeanour.

PREGNANCY.

The medical man may be required to ascertain the existence or non-existence of pregnancy, for legal purposes, not only in cases where it is truly alleged to exist, but where it is feigned or concealed.

Pregnancy may be *feigned* by the unmarried female with a view to extort money, or to induce a paramour or seducer to marry her; or she may bring an action for breach of promise of marriage, and allege pregnancy as a means of influencing the jury in the assessment of damages. It may be pretended by the married, to gratify the wishes of a husband, or to produce a supposititious heir to an estate; and it is pleaded both by married and single women to stay the execution of capital punishment.

Pregnancy may be *concealed* both by the married and unmarried, to avoid disgrace, or with a view of procuring abortion or committing infanticide.

The two cases in which an examination of women alleged to be pregnant is most likely to be required for medico-legal purposes are—1. A case at common law, where a widow upon the death of her husband alleges that she is with child, which allegation if true would disappoint the heirs to the estate; and—2. A case in criminal law, where a female condemned to death pleads pregnancy in stay of execution.

The legal mode of putting the first of these allegations to the test is by the issue of a writ *de Ventre inspiciendo*, the examination being intrusted to a *jury of matrons*, or discreet women, generally twelve in number, who are charged with the duty of ascertaining the fact of the pregnancy, and of narrowly watching the female till her delivery. In the second case, the duty of the jury is to ascertain, not only whether the female is pregnant, but also whether she is *quick with child.*

The jury of matrons has not always been constituted in the same manner; and it is now a common practice to require the aid of one or more skilled medical examiners. Thus in the case of Mrs. Fox,* two

* 'London Med. Gaz.,' vol. xvi. p. 697; vol. xvii. p. 191.

medical men and two matrons were appointed to visit her once a fortnight. In a recent criminal case (case of Mary Weeks, indicted for the wilful murder of George Weeks, Western Circuit, March 20, 1856), the counsel for the defence moved for a stay of execution, as the prisoner was quick with child. The doors of the court were ordered to be locked, and a jury of matrons were called into the box and sworn, and charged to inquire into the fact, whether or not the prisoner was so. Two medical men were also sworn to examine the prisoner, and give evidence before the jury of matrons. The jury retired for a short time, and on returning into court found that the prisoner was so. Sentence was accordingly respited until by due course of nature the prisoner should be delivered.

Another case in which a court of law has interfered on proof of the existence of pregnancy is when a female in this situation is imprisoned, and application is made to admit her to bail. A case for a medical examination may also arise under the act 1 Gul. IV., chap. 22, which provides that the deposition of a witness may be read in evidence in place of a personal appearance where it can be shown to the satisfaction of the judge that the witness is unable, from permanent sickness or other infirmity, to attend the trial. It has been ruled that imminent delivery is a cause for examination under this act.

As the subject of pregnancy is one which involves a great number of details, the several parts of which it consists will be examined in the following order. 1. The signs and symptoms of pregnancy during life; including questions raised by the expulsion of various substances from the womb. 2. Examination of the uterus and its appendages after death, with a view to the discovery of proofs of an existing or previous pregnancy; and 3. Questions of a medico-legal nature connected with pregnancy.

1. SIGNS OF PREGNANCY.

The leading Signs of Pregnancy are here briefly described, the reader being referred for more accurate information to works on midwifery, or to monographs treating expressly on this subject.*

The Constitutional Signs or Symptoms of Pregnancy are:—an irritable and capricious temper, melancholy, languor; a worn and dejected expression of countenance, and emaciation; nausea, heartburn, loathing of food, a capricious, variable, or depraved appetite; vomiting, especially in the morning, and a costive state of bowels; feverishness, determination of blood to the head, with eruptions on the face; and in some cases salivation, and pains of the face and teeth.

* Consult Montgomery, 'Cyclo. of Pract. Med.,' art. Pregnancy, and his work on the 'Signs of Pregnancy.' See also Dr. Tanner's recent work on the same subject.

These symptoms, taken separately, have little or no value, and even when several of them coexist, they are far from conclusive.

The Breasts.—The changes which take place in the breasts in consequence of pregnancy consist, (*a*) in increased size and firmness; (*b*) in the formation around the nipple of a moist dark circle, or areola, studded with mucous follicles; and (*c*) in the secretion of lymph (a mixture of milk and serum), which flows from the nipple.

Signs referable to the Uterus.—These are, *a*. changes in the size and shape of the abdomen; *b*. quickening; *c*. suppression of the catamenia; *d*. changes in the neck and orifice of the uterus; *e*. increased size of the uterus; *f*. ballottement; *g*. discoloration of the mucous membrane of the vagina; *h*. sounds heard on the application of the stethoscope to the abdomen.

a. The Changes in the Size and Shape of the Abdomen—consist in a uniform enlargement, first perceptible about the end of the third month, and progressively increasing up to the period of delivery. Before the third month the uterus sinking into the pelvis causes the abdomen to appear flattened, and the umbilicus depressed.

b. Quickening—is vulgarly attributed to the movements of the child, but more correctly to a sudden change in the position of the uterus, which takes place, for the most part, between the 14th and 18th weeks, but sometimes as early as the 12th week. It is a very fallacious sign; for these movements are sometimes not perceived at all, at others confounded with the motions of flatus, with changes in the position of the viscera, or with sudden contractions of the abdominal muscles.

c. Suppression of the Catamenia.—The menses may be suppressed for long periods, from causes other than pregnancy; or they may be present for one or two periods after conception, or during the whole course of gestation; or, again, they may be absent at all other times, and make their appearance only after conception. Moreover, the sign is wanting in females who have become pregnant without having menstruated. A female who is really pregnant may also conceal the fact from her friends, by pretending that she is regular, and imitating the catamenia by blood.

d. The Changes in the Neck and Orifice of the Uterus.—The neck of the impregnated womb is fuller, rounder, softer, and more elastic; the margins, or lips, lose their well-defined edge, and become soft, swollen, and indistinct; the orifice, instead of being transverse, becomes circular, and admits the point of the finger more readily, and to a greater depth; and in advanced periods of pregnancy the neck becomes shorter, and is at length no longer to be felt. The position of the womb also changes as pregnancy advances. The organ rises higher, the fundus is tilted forward and the neck backward.

e. Increased Size of the Uterus.—During the first three months. the uterus not having yet risen out of the pelvis, no increase of size

can be discovered, either by external examination or by examination per vaginam ; but at the end of the fourth month it may sometimes be felt above the pubes; and during the fifth, it may be felt both externally and per vaginam.

As this enlargement of the uterus may be due to any cause gradually distending its cavity, too much reliance must not be placed upon it as a sign of pregnancy.

f. Ballottement.—This name has been given to the sensation produced by the fall of the fœtus after it has been jerked upwards by a brisk movement of the finger. It is not available till after the end of the fourth month, and rarely much beyond the completion of the sixth. Its application, therefore, is limited, and in resorting to it much practice and some precautions are required. In practised hands it is a sign of great value.

g. Discoloration of the Mucous Membrane of the Vagina.—M. Jacquemin states that during pregnancy the entire mucous membrane of the vagina has a deep violet tint, like that of lees of wine, and that this change of colour constitutes an infallible sign of pregnancy. This statement has been confirmed by more than one competent observer; but the test does not admit of frequent application in this country.

h. Application of the Stethoscope.—Two sounds may be heard on applying the stethoscope over the region of the uterus in a pregnant female ; the pulsations of the fœtal heart, and the uterine murmur.

The Fœtal Pulse.—The pulsations of the fœtal heart vary from 120 to 160 in a minute, and bear no relation to the pulse of the mother. Each pulse is double, and resembles the tick of a watch heard through the pillow. It is not always heard in the same position, but generally on one side, at a point nearly midway between the umbilicus and the anterior superior spine of the ilium. It is also occasionally inaudible. Once heard, it is a sure sign of pregnancy. It fails in the case of a dead fœtus, and it is also inapplicable at an early period of utero-gestation.

The Uterine Murmur.—This is a low murmuring, or cooing sound, resembling that made by blowing gently over the lip of a wide-mouthed phial. It is synchronous with the pulse of the mother, and its relative situation remains the same during the whole period of gestation. It may generally be detected in the lateral or anterior parts of the uterus, and is first distinctly audible about the end of the fourth month.

Condition of the Urine.—The urine of a pregnant woman, after standing one or two days, becomes turbid, and numerous fatty globules rise to the surface, and form an opaque creamy pellicle, with adherent caseous matter, not unlike that which forms on the surface of cold mutton broth. This crust swims on the surface for three or four days, but breaks up and disappears with advancing putrefaction. To this fatty pellicle the name of *Kyestein* has been given. It has also been recently shown that the urine of pregnant women contains grape-sugar.

Of the foregoing signs of pregnancy, there are very few which can be deemed conclusive when taken by themselves; while many of them are extremely fallacious, and are liable to be simulated by various diseased conditions, or to be obscured by coexisting diseases of the uterus itself, or of the abdominal viscera. Some of the most valuable of these signs can only be duly appreciated by experienced persons, to whom alone this class of inquiries should be intrusted.

The evidence of pregnancy afforded by substances expelled from the womb has not a very frequent medico-legal application, and may be very briefly discussed.

The chief of these substances are, 1. An early ovum. 2. Moles. 3. Hydatids. 4. False membranes.

1. *An Early Ovum.*—We may recognize an early ovum either by the characters of the contained fœtus, or by that of the surrounding membranes. The appearances presented by the fœtus itself during the early stages of its development will be examined in the next chapter. The membranes of the ovum present highly characteristic appearances. The decidua is characterized by its soft, rich, pulpy appearance and strong red colour, by its rough external surface perforated by small foramina, and its smooth internal surface. The inner decidua is known by its smooth outer surface, and its internal one covered with filaments, which receive the arborescent villi from the surface of the chorion. These appearances are never assumed by any product of disease.

2. *Moles.*—Some authors have regarded these bodies as products of conception, and some as occurring independent of sexual intercourse. If products of conception, they will be identified as such by the discovery of some parts belonging unequivocally to an ovum; but if no such parts can be discovered, we are bound not to assume that the substance under examination was due to impregnation.

3. *Hydatids.*—There is a decided balance of opinion in favour of Hydatids being in all cases the product of conception; hence they form an exception to the rule just laid down, with regard to moles, and it is not necessary to discover traces of an ovum in order to form a decided opinion. It must be recollected, however, that Hydatids may spring from portions of retained membrane, and may not be expelled for several months, so that, though furnishing proof of pregnancy, they would not serve to fix its date.

4. *False Membranes.*—False Membranes are often expelled in dysmenorrhœa; and a superficial and careless observer might pronounce them to be the product of conception. The general rule already laid down, that no substance expelled from the uterus should be regarded as a product of conception, unless it contain well-marked traces of some part or other of an ovum, must be observed also in this case.

2. *Examination of the Uterus and its Appendages after death.*

The examination of the uterus and ovaries after death may become necessary, with a view of determining the existence, or previous oc-

currence, of pregnancy; a fact of much importance in certain medico-legal cases.

The *uterus* itself, by presenting the small size of the virgin state, may at once negative the supposition of pregnancy. Or it may be found enlarged, but empty, and marked by some of the changes which accompany gestation. In this case we should not be justified in asserting that pregnancy had existed, because these appearances may be due to any tumour which had distended the organ, and at the same time formed a vascular connection with its internal surface. If, instead of being empty, the womb should be found to contain any substance, it must be carefully examined, and if traces of an ovum should be discovered, the fact of previous impregnation would be made out.

Much importance was formerly attached to certain appearances in the *ovaries*, as signs of pregnancy; and on the trial of Mr. Agnus of Liverpool for the murder of Miss Burns, the discovery of a *corpus luteum* in the ovary of Miss Burns was held to prove the fact of recent pregnancy, in the face of much difference of opinion as to the conclusions to be drawn from the appearance of the uterus itself.

The value of the corpus luteum as a sign of previous impregnation has been a subject of lively discussion, and the characters by which the true corpus luteum, the product of conception, may be distinguished from the false corpus luteum, found in virgins, have been very minutely described. It results from this discussion, that the distinction between the true and the false corpus luteum is not of so marked and decisive a character as to justify us in making use of it for medico-legal purposes.*

3. *Questions of a Medico-legal Nature connected with Pregnancy.*

These questions are—1. What are the limits of child-bearing? 2. Can a woman conceive while in a state of unconsciousness? 3. Can a woman remain ignorant of her pregnancy up to the time of delivery? 4. Does the presence of the hymen rebut the supposition of pregnancy? And 5. Is superfœtation possible?

1. *What are the limits of child-bearing?*—Cases of early fruitfulness are related by high authorities. Thus, Montgomery delivered a female of twins before the completion of her 15th year; La Motte and Sir E. Home give instances of pregnancy in the 13th year; the last-named author another in the 12th; and Bruce, in Abyssinia, and Dunlop, in Bengal, met with mothers of 11 years. Mr. Roberton

* "The fact that a structure, in its essential characters similar to, though smaller than, a corpus luteum, observed during pregnancy, is formed in the human subject independent of impregnation or of sexual union, coupled with the varieties in size of corpora lutea formed during pregnancy, necessarily renders unsafe all evidence of previous impregnation founded on the existence of a corpus luteum in the ovary."—Kirke's 'Physiology,' 1st Edit. p. 606.

gives the case of a factory girl delivered of a still-born child when she had barely completed her 11th year. Blumenbach gives an instance of pregnancy in a Swiss girl in her 9th year (Male, p. 176), and Joubert and Schurigius cases at the same early age (Smith, p. 496).

On the other hand, cases are recorded of pregnancy at very advanced periods of life. Bartholomew Mosse mentions four cases of women pregnant in their 51st year, and Dr. Labatt of Dublin one; Knebel, La Motte, and Roberton, each one in the 52nd year; Roberton one in the 53rd year; Bartholomew Mosse, Knebel, and Roberton each one in the 54th year; a case of pregnancy at the same age (that of Mrs. Ashley) is also related in the 'Edinburgh Annual Register' for 1816. In a French case, in which the succession to an estate was disputed on the ground of the mother being 58 years old when the child was born, a decision was given in favour of the fact. Pliny, Valescus de Tarenta, and Marra of Venice, record cases of pregnancy at 60. The Countess de Taxis is stated to have borne a healthy child at the age of 62 (Smith, p. 496). Capuron states that a woman of 63 was generally believed in Paris to have given birth to a daughter; and, lastly, Beck quotes a case from the 'Boston Medical and Surgical Journal,' of a woman at Whitehall (State of New York) becoming a mother at 64.

It will be observed that at each age from the age of 51 to the age of 54 inclusive, instances of pregnancy are recorded on undoubted authority. After this age there is a break in the chain of evidence, the earliest of the more remarkable instances having occurred at 58, and the latest at 64 years of age.

As the first and last appearance of the menses are usually supposed to fix the limits of possible fruitfulness, and as the coincidence of such early and late occurrence of menstruation does certainly lend support to the cases of early and late pregnancy, it may be well to state that menstruation at nine years of age is not an uncommon occurrence either in England or on the Continent; that the author, out of 1,500 cases to which he directed his inquiries, found one of menstruation before the completion of the eighth year, and that Male met with two instances of regular return of the catamenia and partial development of the breasts at six years of age. In one French case, menstruation is recorded at five years. The occurrence of the menstrual discharge, even in the first year of life, rests on good authority.

On the other hand, the author has known the function of menstruation to continue uninterruptedly so late as the 57th year; and Dr. James Reid has recorded instances of menstruation for every year from that age up to the 69th, inclusive. Cases of menstruation recurring, after interruption, at a still more advanced age are also on record.

As the age at which the menses first make their appearance admits occasionally of medico-legal application, it may be well to state that

the 14th and 15th years are the most common epoch of their commencement, then the 16th, then the 17th and 13th, then the 18th and 12th, and the other ages in the following order:—the 11th, the 19th, the 20th, the 10th, the 21st, the 22nd, the 9th, and the 23rd.

The most common period for the disappearance of the menses would seem to be from the 45th to the 50th year, inclusive; but the instances before 40 and after 50 are numerous.

2. *Can a woman conceive while in a state of unconsciousness?*—The answer to this question must be in the affirmative. Capuron says, "It is a fact, which experience has more than once confirmed, that a woman may become with child while in a state of hysteria, under the influence of narcotics, during asphyxia, drunkenness, or *deep sleep*, and consequently without being conscious of it, or sharing the enjoyment of the man who dishonours her." This statement is fully borne out by a case given by Capuron himself, in which the unconscious intercourse took place during a profound sleep produced by punch; by a case cited by Beck, Art. Pregnancy, in which the same result was brought about by wine; and by a third case communicated to Foderé by Desgranges, in which opium was administered with the same intent.

As examples of conception taking place from intercourse during profound sleep, two cases may be cited, the one on the authority of Dr. Gooch, the other on that of Dr. Cusack. Of unconscious intercourse followed by pregnancy during a prolonged fainting fit, an instance was communicated to the author by Mr. Hewett of Berkshire; and of violation with the same result during a state of asphyxia, or apparent death, an instance is cited by Foderé (vol. i., p. 500) from the 'Causes Célèbres.'

It appears, then, that there are various states of system accompanied by insensibility, during which connection may take place followed by conception, the female being unconscious of the occurrence, and not suspecting it afterwards.

3. *Can a Woman remain ignorant of her Pregnancy up to the time of Delivery?*—It is obvious that in the cases just referred to this is quite possible. A woman who is not conscious of having exposed herself to the risk of becoming a mother, would naturally attribute her enlargement, and all the symptoms of pregnancy accompanying it, to any cause but the true one. There is another case in which such ignorance is possible; and that is where the female has yielded to the solicitations of a lover in consequence of solemn assurances that, under certain circumstances, connection may take place without danger. Thus Foderé cites a case on the authority of M. Desgranges, in which a young girl, after resisting the repeated solicitations of her lover, yielded to his desires in a bath, under the assurance that in that situation she could not conceive. She became a mother, however, but appeared to remain ignorant of her situation till the last. M. Des-

granges states that she always affirmed to him that the circumstance of the connection having taken place in the water had removed all idea of pregnancy.* There is also an opinion prevailing that a single act of intercourse is unattended with danger; and another popular prejudice, that provided the act of intercourse is incomplete, and the hymen remains uninjured, impregnation is impossible. Foderé states that many cases have occurred of females asserting that they were not pregnant up to the last, on the strength of the precautions which they had taken.

Now in all such cases it is obviously possible that the female may attribute the symptoms of pregnancy to disease, and really believe what she so much desires should be true. But it is in the highest degree improbable that a woman who has had connection under any circumstances should not have serious misgivings as to the real cause of her altered state, and as to the infallibility of the popular belief on which she had acted. In this, as in other things, the wish is father to the thought, and as the married woman, anxious for offspring, construes every unusual sensation into a sign of pregnancy, and makes serious preparations for the important event which is to crown her wishes, so the single woman, whose wishes all tend the other way, may sincerely attribute to any cause but the true one, every symptom of an event which threatens her with shame.

4. *Does the presence of the Hymen rebut the supposition of Pregnancy?*—This question is easily answered, for it has already been shown (p. 36) that the hymen may exist in spite of repeated intercourse, and that it may not be destroyed even by delivery. Its presence, therefore, does not negative the supposition of pregnancy.

5. *Is Superfœtation possible?*—As this question has an important bearing upon legitimacy, it demands a careful examination. Superfœtation is defined as the conception of a second embryo during the gestation of the first, the products of the two distinct conceptions being born either at the same or at different times. Some light is thrown upon this question by more than one well-authenticated case in which a woman has been delivered of twins of different colours, and both of them fully formed. The two following are taken from many similar ones quoted or referred to by Beck:† "A female at Charleston, in South Carolina, was delivered in 1714 of twins, within a very short time of each other. One was found to be black, and the other white. This variety of colour led to an investigation; and the female confessed that on a particular day, immediately after her husband had left his bed, a negro entered her room, and by threatening to murder

* Foderé, vol. i. pp. 496-7. Beck quotes this case as an illustration of the position that ignorance of pregnancy may exist "when the female is an idiot." This case does not appear to be in point, for though M. Desgranges describes the girl as "assez niaise," there seems no good reason to regard her as an idiot.

† 'Medical Jurisprudence,' Art. Pregnancy.

her if she did not consent, had connection with her." This case is related on the authority of Buffon. The following case is mentioned by Dr. Moseley as occurring within his time at Shortwood estate, in the island of Jamaica: "A negro woman brought forth two children at a birth, both of a size; *one of which was a negro, and the other a mulatto.* On being interrogated upon the occasion of their dissimilitude, she said she perfectly well knew the cause of it; which was, that a white man belonging to the estate came to her hut one morning before she was up, and she suffered his embraces almost instantly after her black husband had quitted her." A case still more remarkable than either of the foregoing, and scarcely credible, is quoted from the Rev. Dr. Walsh's Notices of Brazil. "It was communicated to me," says Dr. Walsh, "by the Sargenté Mor of the San José gold district (Brazil). A Creole woman with whom he was acquainted in the neighbourhood had three children at a birth, of three different colours, white, brown, and black, with all the features of the respective classes.

In the first two cases there is nothing very remarkable. It is easy to imagine conception taking place in the same ovary or in different ovaries, from the nearly simultaneous application of semen, whether of the same man or of different men.

Now these are cases in which the two children are of the full size, and differ in nothing but colour from children of one father and one conception. There is another class of cases equally easy to believe and to understand, in which the birth of two children is separated by a short interval, or by an interval closely corresponding to their relative size and degree of development, on the supposition of their being twins. Of the former class of cases the following, cited by Beck, from the *Consilia* of Zacchias, is an example:—"J. N. Sobrejus lost his life in a quarrel, leaving his wife pregnant. Eight months after his death she was delivered of a deformed child, which died in the birth. Her abdomen remained large, and it was suspected that a second infant was contained in it, but all efforts to procure its delivery proved fruitless. One month and a day thereafter, the widow was again taken in labour, and brought forth a perfect living child. The relations of the husband contested its legitimacy, on the ground that it was the fruit of a superfœtation, and Zacchias was consulted on the subject. He agreed that the two infants could not have been the product of one conception, since the interval between their birth was so great: but advanced it as his opinion, that the *first* was the product of a superfœtation, and conceived a month after the other. This he strengthened by the fact that the husband died suddenly while in a state of perfect health. His opinion preserved the character of the mother, and also gave her those legal rights to which her situation entitled her." Zacchias seems, in this case, to have chosen the most improbable of two suppositions. It is certainly more easy to suppose that the birth of twins, the product of the same conception, may take place at two

different times, than that they should be the products of two different conceptions; and it is by no means easy to understand on what data Zacchias could found his opinion that the child first born was the last conceived. In a question of so much difficulty, the wisest course seems to be to prefer that interpretation which involves the least difficulty, and which is most consistent with experience. Now the expulsion of twins at different times is allowed to be a common event, of which examples are to be found in most works on midwifery. The most feasible opinion, then, seems to be, that this was a case of twins conceived at the same time, but of which one was discharged before the other.

But there are cases on record which do not admit of so easy an explanation, and which certainly countenance the theory of a double conception.

The wife of Raymond Villard, of Lyons, married at the age of twenty-two, and became pregnant after an interval of five years, but had an abortion at the seventh month, on the 20th of May, 1779. She conceived again within a month; and on the 20th of January, 1780, eight months after her delivery, and seven months from her second conception, she was suddenly delivered of a daughter. This delivery was not, however, followed by the usual symptoms—no milk appeared, the lochia were wanting, and the abdomen did not diminish in size. It was accordingly found necessary to procure a nurse for the child.

Two surgeons who visited the female were at a loss with respect to her situation, and called Dr. Desgranges in consultation, who declared that she had a second child in the womb. Three weeks after her delivery she again felt the motions of a fœtus; the abdomen again increased in size, and on the 6th of July, of the same year, 1780 (five months and sixteen days after the first birth), she was again delivered of a living daughter. The milk now appeared, and she was enabled to nurse the child.

Dr. Desgranges, after stating his firm conviction that these two children were conceived at an interval of some months, adds, that this second child could not have been conceived after the delivery of the first, inasmuch as no sexual intercourse took place between the husband and wife till twenty days after, which would have made the age of the second child only four months twenty-seven days.

On the 19th of January, 1782, the mother presented the two children, with extracts from the baptismal register, before two notaries of Lyons, in order to attest the facts above stated.*

Assuming that the facts of this case are correctly stated, it must be admitted to be nearly conclusive as to the possibility of superfœtation; for if we deny this, and assume both children to have been the product of a simultaneous conception, and the last child to have been at

* Foderé, vol. i. p. 485.

full term, the first child, which, be it observed, in common with the other survived its birth between one and two years at the least, must have been born alive at three months and a half; or, if the first child be admitted to be seven months old, the second must have been born alive at six weeks, which is obviously absurd. The alternative supposition, that the second child was the fruit of sexual intercourse taking place subsequent to the delivery of the first, as stated by Dr. Desgranges himself, is also in the highest degree improbable, for it supposes a child, born before the completion of the fifth month, to be reared! This improbability is increased by the absence of all allusion to any peculiar difficulty in rearing the child. The only remaining supposition, namely, that the second child was a twin born after a gestation of twelve months and a half, presents similar difficulties.

Dr. Maton has also related a well-authenticated case, in which two male children (both of which were "born perfect") were brought forth at an interval of nearly three calendar months. If this had been a case of simultaneous conception, the one would have been six months or less, the other nine months or less.

Additional cases are referred to by Beck, in three of which there was an interval of one month, in two an interval of two months, and in one an interval of four months.

In deciding this question, those cases only must be admitted to have any weight in which the interval between the births is considerable; for, where the interval is short, if we suppose the child last born to be mature, the first may have been eight or seven months old, which is quite reconcilable with the supposition of its being reared. When, however, the interval is one of four months, if we assume, as before, that the child last born is mature, the first cannot be more than five months old, an age at which it is highly improbable that a child could be reared.

In any cases that may hereafter occur, it will be important to observe the size and degree of development of the children, as this must always be an essential element of the inquiry. But it must not be forgotten that even the products of the same conception may differ greatly in size, and yet both be healthy children.

This fact is well illustrated by a case brought under the notice of the author by Mr. Streeter, in which female twins, five and a quarter months old, were born enveloped in a common chorion. The one was more than twice the size of the other, but the smaller fœtus alone had made successful efforts to respire.

If the single case of the wife of Raymond Villard be allowed to be correctly stated, the doctrine of superfœtation must be admitted to be highly probable; but, as there may still be room for doubt, it may be useful to subjoin the chief arguments employed by the advocates and opponents of that doctrine.

The opponents of superfœtation allege that the occurrence is impossible, because 1, shortly after conception the os tincæ, as well as

the internal apertures of the Fallopian tubes, are closed by a thick tenacious mucus. 2. The membrana decidua, which is also formed soon after conception, lines the uterus, and aids in obliterating the openings into its cavity. 3. That when the uterus is impregnated, the Fallopian tubes, instead of running horizontally to the ovaria, li. parallel to the sides, so that if a second embryo were formed within the ovarium, the tubes could not embrace it in order to convey it to the uterus. And 4, that the arrival of a new embryo in the uterus would prove destructive to the first.

The last objection is founded upon a bare assumption, and may therefore be summarily dismissed. The third objection, if valid, must prove fatal to the doctrine of superfœtation; but though this obstacle may exist in the fully developed uterus, the ovary and Fallopian tubes are not more prevented from coming into contact with each other in the early stage of utero-gestation, at which alone superfœtation is alleged to take place, than in the unimpregnated state. The answer to the first two objections is an obvious one. Neither the tenacious mucus nor the newly-formed decidua, though in contact with the orifices and cells of the uterus, adheres so firmly to it as not to admit the passage of the semen. The fact of menstruation in numerous cases occurring during a part or the whole of pregnancy seems to prove, that the adhesion of this tenacious mucus and of the decidua is by no means so firm as to forbid the passage of fluid; and this argument is strengthened by the frequent occurrence of hæmorrhage in the advanced stages of pregnancy in consequence of partial detachment of the placenta. The arguments advanced against the doctrine of superfœtation are certainly not of sufficient weight to counterbalance the improbabilities set forth in the case of Raymond Villard; and unless that case can be shown to be untrustworthy, there seems to be no alternative but to admit the truth of the doctrine.

If, then, we admit the possibility of superfœtation, the question arises, Can we explain this occurrence in such a manner as to avoid the objections of its opponents? The existence of double uteri, and more rarely of double vaginæ also, suggests the required explanation; and as the recorded cases of this malformation are much more numerous than those of superfœtation, it is quite possible that some of the latter may be explained by the malformation in question.*

That this malformation does really explain some cases of superfœtation is proved by a case related by Scheider of a woman who, six weeks after marriage, bore a four months' child, and forty weeks after marriage mature twins. On examination, the uterus and vagina were both found double, and each vagina had a separate orifice.†

* Dr. Cassan ('Recherches sur les Cas d'Utérus Double, et de Superfœtation') has collected forty-one cases, in three of which both uterus and vagina were double; and Beck has added eleven others, in three of which the vagina was double.

† Müller's 'Archives,' 1836, and 'London Med. Gaz.,' vol. xx. p. 408.

DELIVERY.

Delivery, like pregnancy, may be either concealed or pretended;—concealed, with a view either of hiding shame, or of effecting the destruction of the child; and pretended, in order to produce a supposititious heir to an estate, to influence the feelings of a paramour with a view to marriage, or to satisfy the wishes or appease the anger of a husband.

The medical man, then, may be called upon for medico-legal purposes to ascertain the existence of delivery in concealed cases, and its non-existence in pretended cases. The latter class of cases is comparatively rare; but the former is of frequent occurrence, especially in accusations of infanticide, when we are called upon to examine the suspected mother, with a view to determine whether she has been recently delivered. A similar inquiry may have to be instituted in the dead. The medical man may also be called upon to determine whether a female has borne children at a former period. He may further be questioned (especially in trials for infanticide) as to the possibility of a female being delivered in a state of unconsciousness, or in such a position and in such circumstances as, without any criminal act of her own, to endanger the life of her offspring.

This subject, therefore, medico-legally considered, resolves itself into four heads or divisions:—1. The signs of recent Delivery in the Living. 2. The signs of recent Delivery in the Dead. 3. The signs of Delivery at a former and more remote period. 4. Other medico-legal questions connected with Delivery.

1. *Signs of recent Delivery in the Living.*—When an examination is made within a few days after delivery, the following appearances are present:—

1. The *countenance* is pale, resembling that of a person recovering from a slight illness, and the eye is sunken and surrounded by a dark circle. The pulse is increased in frequency, and the skin is soft and warm, and moistened with a perspiration of a peculiar and unpleasant odour.

2. The *breasts*, especially if examined on the third or fourth day after delivery, are found full, tense, and knotty, and when pressed or drawn yield a milky fluid. The nipples are turgid, and the areola presents the appearances proper to the state of Pregnancy.

3. The *abdomen* is distended, its integuments relaxed and thrown into folds, and its lower part, from the pubes to the umbilicus, marked by light-coloured broken streaks or cracks. On pressing the hand firmly over the pubic region, we feel the tumour produced by the imperfectly contracted uterus, about the size of the head of a new-born child, rising three or four inches above the brim of the pelvis, and inclining more to one side than the other.

4. The *external parts of generation* bear distinct marks of the dis-

tension and injury which they have recently undergone. They are swollen and relaxed, and not uncommonly bruised and torn, especially after a first labour. In first deliveries, also, the fourchette is often ruptured, and the injury sometimes extends deep into the perineum.

5. On examination *per vaginam* we discover the *uterus* enlarged, and corresponding with the external tumour, the os uteri gaping, so as to admit two or three fingers, and its margins relaxed, flabby, and fissured. If the examination is made within a few hours after delivery, the orifice is so open that its margins cannot be distinguished, and it seems to be a continuation of the vagina. The vagina itself is also dilated and relaxed, and its internal surface is smooth from the obliteration of the rugæ.

6. The *lochia.* From the time of delivery and for the first two or three days, but in some instances much longer, a sanguineous discharge flows from the genitals. It then becomes nearly colourless, or acquires a light brown or dirty greenish hue, whence the vulgar name "green waters." This discharge has a peculiar, sour odour, resembling that of fish-oil—an odour very difficult to conceal or destroy.

The value of these signs of recent delivery depends upon their being found in combination; the uterus and vagina may be enlarged, and the external parts injured by a tumour of any kind recently expelled, and this may be followed by a discharge from the genitals. The breasts, moreover, may enlarge and secrete milk, from sympathy with the distended uterus; and the abdomen may display all the marks of recent distension.

It is of the first importance that the examination should be made without delay; for even in cases in which the signs of delivery are most strongly marked, they may disappear before the tenth day; and as a general rule it may be stated that after that date no satisfactory results are to be expected. In many cases it will be difficult to give a decided opinion even before this period has elapsed. Much depends on the relative size of the fœtus, and on the constitution of the mother.

In cases of abortion occurring in the early months, the appearances would be slight and evanescent, and before the end of the second month it is generally admitted that no evidence of recent abortion would be discoverable. All these circumstances must be taken into account in forming our decision.

2. *Signs of recent Delivery in the Dead.*—The external parts present the same appearance in the dead as in the living. On opening the cavity of the abdomen, the uterus is found to present different appearances, according to the time which has elapsed between delivery and death. If death has taken place immediately after parturition, the uterus will be found flat and flabby, from 9 to 12 inches long, the os uteri wide open, its cavity containing large coagula of blood, and the internal surface lined by the soft and pulpy remains of the decidua. The attachment of the placenta is distinctly visible, characterized by

its darker colour, the small number of flocculi, and the semilunar openings upon its surface.

The size of the uterus at periods more remote from delivery varies with the degree of contraction which has taken place. In the first two or three days after delivery of a mature child, it may be stated to be about seven inches long by four broad; its external surface is vascular, and marked by purple patches; when divided it is found to be from an inch to an inch and a half in thickness, of the colour and consistence of firm muscular fibre. Its internal surface retains the appearances just described. At the end of a week, the length of the uterus is between five and six inches. It is now about an inch in thickness; less vascular, but more firm in texture. The inner surface is still bloody, and partially covered by decidua. At the end of a fortnight the length of the uterus does not exceed five inches, and after the lapse of a month, it has resumed its original size, but the os uteri never closes so completely as in the virgin state.

The Fallopian tubes and one or both of the ovaries are found turgid and vascular, and on being cut into present one or more corpora lutea.

3. *Signs of Delivery at a former and more remote period.*—The external marks consist of silvery lines, or "shining broken streaks, like the remains of cracks," on the skin of the breasts and abdomen. These marks are often absent, and when present they furnish proof merely of great previous distension from whatever cause, followed by sudden subsidence. The marks on the abdomen are, for obvious reasons, the most fallacious; but those on the breasts are extremely unlikely to be caused by any other form of distension. When the two are found in combination, they furnish strong evidence either of a former delivery, or of some distension of the uterus producing sympathetic enlargement of the breasts. An experienced hand will detect in the os uteri a peculiar, jagged condition, on which much stress has been laid as evidence of a former delivery. The marks of a previous rupture of the fourchette or perineum will also tend to confirm the evidence derived from the external examination of the abdomen and breasts. On the other hand, we may find negative evidence of a still more satisfactory character; as, for instance, a state of imperforation or narrowness of the parts quite inconsistent with the idea either of pregnancy or delivery. A perfect hymen would also afford a presumption against a previous delivery. (See p. 36.) The following case will serve to illustrate the difficulty which may exist of proving the fact of a previous delivery:—"We very lately examined a patient who had borne five children, and nursed three of them, the youngest being now five years old; the breasts were small, but neither flaccid nor pendulous; the nipples short, with not the least shade of brown colour in the areolæ, which exhibited only the delicate rose colour so often observed on that part of the virgin breast; there were neither lines nor spots of any kind on the abdomen; the os uteri was small

and natural; the vagina contracted, and the fourchette perfectly entire. It should be mentioned that this lady never carried her children beyond the end of the eighth month."*

4. *Other Medico-legal Questions connected with Delivery.*—Two questions connected with the subject of delivery still remain to be examined. 1. Can a woman be delivered in a state of unconsciousness? 2. Can a woman, if alone and without assistance, prevent her child from perishing after delivery? The first of these questions alone will be examined in this place; the second belongs more properly to the subject of Infanticide.

Can a woman be delivered in a state of unconsciousness? This question can be answered in the affirmative. The event may happen under the influence of narcotics or ardent spirits; during coma, delirium, or puerperal convulsions; during an attack of apoplexy; during deep sleep; and during suspended animation. Cases of unconscious delivery are of rare occurrence, and not very likely to happen in a female pregnant for the first time. In women, however, who have borne many children, and who have naturally easy deliveries, such an event is more probable.

* Montgomery: 'Cyclo. Pract. Med.,' vol. iv. p. 504.

CHAPTER III.

FŒTICIDE. INFANTICIDE. LEGITIMACY.

THESE subjects cannot be understood without a preliminary knowledge of the growth and development of the Embryo and Fœtus.

ON THE GROWTH AND DEVELOPMENT OF THE FŒTUS.

It is commonly asserted that no distinct ovum containing a defined embryo can be discovered in the uterus before the 20th or 22nd day; but Velpeau* has seen three ova which were not more than twelve days old, and Sir E. Home found an ovum of a very minute size in the uterus only eight days after impregnation.† The following account of the development of the embryo is based chiefly on the description of Devergie,‡ taken conjointly with the estimates of length and weight given by Hamilton, Burns, Capuron, Chaussier, Maygrier, Foderé, Orfila, Devergie, and Velpeau, together with Bichard's measurement of the fœtal skeleton; and reduced, in the case of the French authorities, to the English standards. The embryo at 14 days measures about one-twelfth of an inch, and at three weeks about one-tenth.

Embryo, Three to Four Weeks.—Length, 3 to 5 lines. *Weight*, about 20 grains. *Size*, that of a large ant, a house-fly, or a barley-corn. *Form*, that of a serpent, the head indicated by a swelling, the caudal extremity slender, and terminating in the umbilical cord; the mouth indicated by a cleft; the eyes by two black points; the members beginning to appear as nipple-like protuberances. The chorion villous; but the villosities uniformly diffused over the surface.

Embryo of Six Weeks.—Length, from 7 to 10 lines. *Weight*, from 40 to 75 grains. The face distinct from the cranium; the apertures of the nose, mouth, eyes, and ears perceptible; the head distinct from the thorax; the hands and forearms in the middle of the length, and the fingers distinct; the legs and feet situate near the anus; there is a distinct umbilicus for the attachment of the cord, which consists of the omphalo-mesenteric vessels, of a portion of the urachus, of a part of the intestinal tube, and of filaments which represent the umbilical vessels. The placenta begins to be formed; the chorion and amnion are still separated; the umbilical vesicle is very large. *Points of ossification* in the clavicle and maxillary bone.

* 'Embryologie,' p. 50.
† Gooch's 'Midwifery,' p. 88.
‡ 'Médecine Légale,' art. Infanticide.

Embryo of Two Months.—Length, variously stated at from 1½ inches to 4 inches. *Weight*, 2 to 5 drachms. Rudiments of the nose and lips; palpebral circle beginning to appear; the arms and legs detached from the trunk; clitoris or penis apparent; anus marked by a dark spot; rudiments of lungs, spleen, and supra-renal capsules; cæcum placed behind the umbilicus; digestive canal withdrawn into the abdomen; urachus visible; chorion beginning to touch the amnion at the point opposite the insertion of the placenta; placenta beginning to assume its regular form; umbilical vessels becoming twisted. *Points of ossification* in the frontal bone and in the ribs.

Embryo of Three Months.—Length, variously stated at from 2 inches to 6 inches. *Weight*, from 1 ounce to 3 ounces. The head voluminous; the free margins of the eyelids in contact; membrana pupillaris visible; mouth closed; fingers completely separated; inferior extremities of greater length than the rudimentary tail; clitoris or penis very long; thymus as well as supra-renal capsules present; the two ventricles of the heart distinct. The decidua uterina and decidua reflexa in contact; the funis containing umbilical vessels and a little of the gelatine of Warthon; placenta completely isolated; the umbilical vesicle, allantois, and omphalo-mesenteric vessels have disappeared.

Fœtus of Four Months.—Length, variously stated at from 4½ inches to 8½ inches. *Weight*, 2½ or 3 ounces to 7 or 8 ounces. Skin rosy, and tolerably dense; mouth very large and open; membrana pupillaris very evident; nails beginning to appear; genital organs and sex distinct; gall-bladder appearing; meconium in duodenum; cæcal valve visible; umbilicus placed near the pubes. Complete contact of chorion and amnion; membrane forming at point of attachment of the placenta to the uterus. *Points of ossification* in the inferior part of the sacrum; ossicula auditoria ossified.

Fœtus of Five Months.—Length, variously stated at from 6 to 10½ inches (a still-born male 13 inches, still-born female 13½ inches; male born alive 9 inches, female born alive 10 inches). *Weight*, 5 or 7 ounces to 1 pound 1 ounce. (In one still-born male reported by Schmitt, 1 pound 13 ounces; in one still-born twin female weighed by the author, 1 pound 6 ounces, and in the other 11 ounces.) The volume of the head still comparatively great; nails very distinct; hair beginning to appear; skin without sebaceous covering; heart and kidneys very voluminous; gall-bladder distinct; meconium of a yellowish-green tint occupying commencement of large intestines. *Points of ossification* in pubes and os calcis; germs of the permanent teeth.

Fœtus of Six Months.—Length, variously stated at from 8 inches to 13½ inches. *Weight*, 1 lb. to 2 lbs. 2 oz. Skin presents some appearance of fibrous structure; eyelids still agglutinated; membrana pupillaris still existing; the funis inserted a little above the pubes; face of a purplish red; hair white or silvery; sebaceous covering beginning to appear; meconium in the upper part of the large intes-

tines; liver of dark-red colour; gall-bladder contains insipid serous fluid; testes near kidneys. *Points of ossification* in the four divisions of the sternum. Middle point of the body at the lower end of the sternum.

Fœtus of Seven Months.—Length, variously stated at from 11 inches to 16 inches. *Weight,* 2 lbs. to 4 lbs. 5 oz. Skin of rosy hue, thick and fibrous, and covered with sebaceous matter; nails not reaching to the ends of the fingers; eyelids no longer adhering; membrana pupillaris disappearing; meconium occupying nearly the whole of the large intestine; left lobe of liver almost as large as the right; gall-bladder containing bile; brain firmer; testicles more distant from kidneys. *Point of ossification* in the astragalus. Middle point of the body a little below the end of the sternum.

Fœtus of Eight Months.—Length, from 14 inches to 18 inches. *Weight,* 3 lbs. 4 oz. to 5 lbs. 7 oz. Skin paler, covered with fine short hairs, and with a well-marked sebaceous envelope; nails reaching to the extremities of the fingers; membrana pupillaris disappears; testicles descend into the internal ring. *A point of ossification* in the last vertebra of the sacrum. The middle point of the body nearer the umbilicus than the sternum.

Fœtus at Nine Months, or Full Term.—Length, 16 to 20 inches. *Weight,* 4 lbs. 5 oz. to 7lbs. The head covered with hair from ¾ inch to 1 inch long; skin covered with sebaceous matter; membrana pupillaris absent: testes have passed inguinal ring, and are frequently found in scrotum; meconium at termination of large intestine. *Point of ossification* in the centre of the cartilage at the lower end of the femur; os hyoides not yet ossified; four portions of occipital bone remain distinct; external auditory meatus still cartilaginous.

As the growth and development of the fœtus has an important bearing on the subjects of this chapter, and the estimates just given are obviously too general to be of much use in the decision of medico-legal questions, I have prepared two tables founded upon the accurate observations of different authors, and presenting not only the average weights and measures but the two extremes; for it is obvious that the extreme values which have hitherto been so much neglected in all numerical investigations, are often those which are most required.

Of the following tables, the first* presents the ascertained weight of the fœtus at the several ages specified, and the second † the ascertained length, and in both cases the still-born are distinguished from those born alive: amongst the latter those only being included who had survived their birth one week or less. The foreign weights and measures have been carefully reduced to the English standard, fractional parts of an ounce being omitted in the table of weights. The number of observations has been stated, in order that the value of the several results may be better appreciated, and that fresh observations may at any time be added.

* See page 66. † See page 67.

Table showing the Greatest, Least, and Average Weights of the Fœtus of both Sexes at different Periods of Utero-gestation.*

SEX.		Six Months.			Seven Months.			Eight Months.			Nine Months.		
		Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.	Still-born.	Born alive.	Both.
		4, 8, 12, obs.	7, 11, 18, obs.	11, 19, 30, obs.	15, 19, 36, obs.	20, 19, 43, obs.	35, 38, 79, obs.	20, 18, 43, obs.	31, 22, 57, obs.	51, 40, 100, obs.	70, 58, 143, obs.	135, 88, 248, obs.	205, 146, 391, obs.
		lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Male	max. .	2 14	2 10	2 10	4 12	6 2	6 2	7 5	7 15	7 15	13 11	11 15	13 11
	min. .	1 9	0 14	0 14	2 0	1 9	1 9	2 13	2 2	2 2	2 6	2 8	2 6
	mean .	2 5	2 1	2 2	3 10	3 7	3 8	4 11	4 2	4 5	7 5	6 0	6 8
Female	max. .	3 13	2 16	3 13	5 4	5 5	5 5	6 4	7 7	7 7	12 7	14 0	14 0
	min. .	0 14	1 4	0 14	1 5	2 4	1 5	2 2	1 15	1 15	3 15	2 12	2 12
	mean .	2 1	2 3	2 2	3 6	3 9	3 8	4 3	4 6	4 5	7 6	5 8	6 4
Male and Female	max. .	3 13	2 16	3 13	5 4	6 2	6 2	7 5	7 15	7 15	13 14	14 0	14 0
	min. .	0 14	0 14	0 14	1 5	1 9	1 5	2 2	1 15	1 15	2 6	2 8	2 6
	mean .	2 1	2 2	2 2	3 8	3 7	3 8	4 7	4 4	4 5	7 5	6 1	6 8

* This table is founded upon 293 observations by Lécieux, 93 by Schmitt, 74 made under the direction of Bernt, 17 by Orfila, 16 by Devergie, 19 by Haartmann, 11 by Joerg, 20 by Dr. Alfred Taylor (of which a large proportion are contributed by Dr. Geogehan of Dublin), and 17 by the author. Smaller numbers of facts have been borrowed from Jäger, Mörrike, Dr. Brady, and others. For exact references to the authors, see 'Ed. Med. and Surg. Journal,' Nos. 140 and 150. One case in which the weight at six months amounts to 5 lbs. 1½ oz. is omitted from the table, as the figures are obviously too high, and must be considered as originating in an error or misprint.

Table showing the Greatest, Least, and Average Lengths of the Fœtus of both Sexes at different periods of Utero-Gestation.*

SEX.		SIX MONTHS.						SEVEN MONTHS.						EIGHT MONTHS.						NINE MONTHS.					
		Still-born.		Born alive.		Both.		Still-born.		Born alive.		Both.		Still-born.		Born alive.		Both.		Still-born.		Born alive.		Both.	
		3, 2, 5, obs.		2, 2, 4, obs.		5, 4, 9, obs.		7, 9, 16, obs.		10, 9, 22, obs.		17, 18, 38, obs.		10, 6, 17, obs.		13, 8, 26, obs.		23, 14, 43, obs.		47, 33, 82, obs.		57, 32, 99, obs.		104, 65, 181, obs.	
		in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.
Male	max.	14	6	14	0	14	0	16	7	17	3	17	3	19	0	19	9	19	9	22	11	23	6	23	6
	min.	10	6	14	0	10	6	11	11	12	6	11	11	16	0	14	9	14	9	16	7	17	1	16	7
	mean	12	11	15	6	14	0	14	7	15	5	15	1	17	7	17	0	17	3	20	0	19	6	19	9
Female	max.	16	1	14	6	16	1	16	7	16	6	16	7	18	8	17	10	18	8	22	4	24	0	24	0
	min.	12	10	14	0	12	10	13	0	12	6	12	6	16	7	15	6	15	6	17	0	16	6	16	6
	mean	14	5	14	3	14	4	15	1	14	2	14	7	18	1	16	7	17	2	19	9	19	5	19	7
Male and Female	max.	16	1	14	6	16	1	16	7	17	3	17	3	19	0	19	9	19	9	22	11	24	0	24	0
	min.	10	6	14	0	10	6	11	11	12	6	11	11	16	0	14	9	14	9	16	7	16	6	16	6
	mean	13	7	14	11	14	2	14	10	14	11	14	11	17	8	16	11	17	2	19	11	19	4	19	7

* This table is founded upon 271 observations, of which 98 were by Schmitt, 70 were made under the superintendence of Bernt, 26 by Dervergie, 17 by Billard, 21 by Dr. Alfred Taylor (including those contributed by Dr. Geogehan), and 24 by the author. A few scattered measurements made by Orfila, Madame La Chapelle, &c., complete the number. One instance of 17 in. 1 lin. at the sixth month, and another of 9 in. 10 lin. at the seventh month, are omitted from the table, as being greatly above and below all the other figures for the same ages.

N.B.—It will be observed that the number of observations given in the second line at the head of these tables does not always correspond to the sums of the previous figures. This arises from the introduction of the weights and measures of children of which the sex was not stated.

The weight of the fœtus at full term has been made the subject of many investigations, and as this point is of importance in itself, and interesting as throwing light upon the probable limits of variation at earlier periods of utero-gestation, the results, as deduced from upwards of 20,000 observations, by Quetelet, Camus, Lécieux, and Baudelocque, and by Drs. Macaulay and Clark, including the facts in the preceding table, are subjoined :—

Greatest weight	14 lbs.
Least weight	2 lbs. 6 oz.
Average weight	6 lbs. 11 oz.

Instances are on record of weights greatly exceeding even the maximum now stated. Dr. Merriman records one exceeding 14 lbs. Sir Richard Croft one, and Dewees two, of 15 lbs., Dr. Ramsbotham senior, and Dr. Moore, of New York, instances of 16½ lbs., and Mr. Owens, of Ludlow, one of 17 lbs. 12 oz. Even this great weight is said to have been exceeded.

It is only necessary to add that, as a general rule, still-born children are heavier than those born alive, males than females, single children, *cæteris paribus*, than twins, and twins than triplets.

The length of the fœtus at full term, as given by different English and French authors, is shown in the subjoined statement:—

Greatest length	26 inches.
Least length	17 ,,
Average length	19 ,,

Cases are recorded in which the length has exceeded even this maximum. Dewees, for instance, met with a length of 27 inches.

The length, like the weight, is greater in males than in females, in still-born than in those born alive, and in single children than in twins, triplets, &c.

The signs of maturity or immaturity will be gleaned from the history of the development of the fœtus; and they will be stated more at length under the head of legitimacy, on which question they have an important bearing.

FŒTICIDE, OR CRIMINAL ABORTION.

The crime of abortion consists (see 1 Vic. cap. 85) in unlawfully administering to any woman, or causing to be taken by her, with intent to procure her miscarriage, any poison or other noxious thing, or in unlawfully using for the same purpose any instrument or other means whatsoever.

If the words of the statute were taken literally it would not be necessary to prove that the woman to whom the poison or noxious thing had been given, or force in any way applied, with a view to pro-

cure abortion, was really pregnant, or that abortion had followed the use of these means. The judges, however, have generally held the proof of pregnancy to be necessary. It will also be observed that the statute is silent as to the distinction between women *quick* and *not quick* with child.

In trials for abortion, the first duty of the medical man will be to establish the fact of abortion by an examination of any substances which may have been discharged from the womb. Having ascertained that the substances submitted to his inspection are the products of conception, he may be required to determine whether the abortion was due to natural causes, to the use of drugs, or to violence. For this purpose he will have to form an opinion as to the sufficiency of any means which may have been used to procure the miscarriage. In rare instances, also, he may have to examine the female to whom the *corpus delicti* is stated to belong, in order to determine whether or not she has been recently delivered. Three different examinations therefore may be required.

1. An examination of substances expelled from the womb.
2. An inquiry into the cause of the abortion: and
3. An examination of the female supposed to have miscarried.

1. *Examination of Substances expelled from the Womb.*—It is only in the early periods of gestation that this examination will offer any difficulty. When the embryo has attained a certain degree of development, it will be impossible to confound it with any other substance expelled from the uterus. The rule already laid down (p. 50), in speaking of moles and false membranes as signs of pregnancy, must be observed in cases of alleged abortion, viz. to admit no substance to be a product of conception in which distinct traces of an ovum cannot be recognized. To this rule hydatids form a solitary exception.

Having ascertained that the substance submitted to our inspection is really a product of conception, we must next determine its age; and this will be done by comparing it with the description already given of the growth and development of the embryo and fœtus, p. 63, et seq.

2. *Cause of the Abortion.*—In considering the cause of an abortion attributed to the administration of drugs or the use of force, it is necessary to be armed with some preliminary knowledge respecting the occurrence of abortion from natural causes. This is known to be a very common event, especially in the early months of pregnancy, and it has been variously stated as occurring in 1 out of 12, or even (Dr. Granville) 1 in 3 of the total number of conceptions. Accoucheurs who have had to deal chiefly with women in more advanced periods of pregnancy have estimated the proportion much lower (*e. g.*, 1 in 188, Madame La Chapelle). The causes which occasion this high proportion of miscarriages will be conveniently considered under the title of

Natural Causes of Abortion.—These are either (*a*) *predisposing*, or (*b*) *exciting*. *a*. The *predisposing* causes may affect either the female

herself or the ovum. The females most liable to abortion are the plethoric, the irritable, the nervous, the lymphatic, the feeble, and the ailing. Excessive or irregular menstruation and leucorrhœa are also among the predisposing causes. Females attacked by syphilis, scurvy, asthma, and dropsy, and those affected with malignant diseases, are peculiarly liable to miscarry. Malformations of the pelvis, the small size of the pelvis in those who marry very early, tight lacing, and all diseases of the uterus or its appendages which tend to prevent the complete development of the organ, may be mentioned among the predisposing causes of abortion. To these may be added, a rigidity of the womb, as in those who are pregnant for the first time at a comparatively advanced age, and a relaxed condition of the neck of that organ. Occasionally, abortion has been epidemic, depending upon some peculiar condition of atmosphere.*

The predisposing causes of abortion dependent upon the condition of the ovum are very numerous. especially in the early months. Velpeau states that of upwards of 200 embryos expelled before the end of the third month, at least one half were diseased. The disease may exist in any part of the ovum—in the membranes, in the placenta, or in the fœtus itself. The different forms of disease which may attack these several parts are too numerous to specify in this place; suffice it to observe, that where we can discover any marked disease of the fœtus, or its annexes, we are justified in regarding such disease as affording a strong probability in favour of the abortion having been due to natural causes.

A woman who has once miscarried is likely to miscarry again from the same cause, and at or about the same period of gestation; and it is also usual to attribute a certain effect to the mere force of habit. In the woman, for instance, whom Heberden ('Commentaries,' p. 15), mentions as having miscarried 35 times, it is reasonable to attribute the later abortions in part to the force of habit.

b. The *occasional*, or *exciting* causes of abortion, are not less numerous than the predisposing. Among them may be mentioned all strong and sudden actions of the muscles of the abdomen, in the stronger efforts of expiration, as in coughing, straining efforts to void the urine or fæces, &c.; violent exercise, as in dancing; profuse discharges from the bowels or from the womb itself; undue excitement of the genital organs; blows, and various forms of mechanical injury.

All these occasional or exciting causes will fail of producing abortion when the ovum is sound, and the female healthy; while, on the other hand, the most careful abstinence from all the exciting causes will not prevent abortion when the predisposition from either cause is strong.

The *criminal means resorted to with a view of destroying the fœtus* are best divided into two classes, *general* and *local;* the first acting

* See references to these epidemics in Velpeau's 'Art des Accouchemens,' art. Avortement.

through the constitution of the mother; the second by immediate application to the abdomen or uterus.

1. *Constitutional Means. Venæsection.*—The confidence placed by the vulgar in this remedy comes, like many other popular fallacies, from high medical authority—that of Hippocrates. But it is merely a *vulgar error.* It is a notorious fact that pregnant women bear blood-letting well, and that it is often the best means of averting a threatened abortion. The assumption that blood-letting promotes abortion is moreover rebutted by facts adduced by several high authorities. Cases are recorded of women bled 48, 80, and 87 times in the course of their pregnancies, and yet without occasioning miscarriage; and Dr. Rush, who bled very freely in the yellow fever of 1793, asserts that not one pregnant woman to whom he prescribed bleeding died or miscarried.

The popular belief in the efficacy of the abstraction of blood from the foot seems to rest on no better foundation, nor does the removal of blood by *leeches* applied to the *anus* or *vulva*—a practice much less frequently resorted to in this country than in France—appear to possess any peculiar efficacy.

Emetics.—It is well known that during the early months of pregnancy, and even in some instances throughout the entire duration of it, severe and distressing vomiting occurs, but without producing abortion. This fact affords some presumption against the efficacy of emetics—a presumption strengthened by the failure of several active irritant poisons productive of violent vomiting in bringing about miscarriage. In females strongly predisposed to abortion emetics would, however, be likely to occasion it.

Cathartics.—These remedies, too, may be given repeatedly, and in very large doses, without producing abortion. Dr. Rush's experience in the yellow fever of 1793 is conclusive on this point.* But it is not to be doubted that hypercatharsis, but especially that resulting from remedies acting chiefly on the rectum, is not without danger to the life of the fœtus, when there is a decided predisposition to abortion.

Diuretics.—These remedies are mentioned as calculated to produce abortion, but without sufficient reason. Irritant poisons, which act in moderate doses as diuretics (*e. g.*, nitre), may occasion abortion; but not simply by their diuretic action.

One of the irritant poisons which powerfully affects the urinary organs is specially deserving of notice in this place: namely, *cantharides.* This active substance combines the effect of a violent emetic, a strong purgative, and a most effective diuretic, and acts violently on the organs in the immediate neighbourhood of the uterus, viz., the bladder and the rectum, occasioning also intense fever and great debility; and yet even this drug given in full doses may fail (as in a case related by Mr. Lucas, of Leeds) in producing abortion. The occasional and even frequent failure of such active poisons renders the efficacy of less

* 'Med. Observations and Inquiries,' vol. iii. p. 249.

powerful remedies extremely doubtful, unless there is in the female a very decided predisposition to miscarry.

Emmenagogues.—Under this name a vast number of active and inert remedies are classed, by far the majority of which have as little effect on the uterine system as they have on other parts of the body. The medicines which Beck notices under this head are *savin*, *mercury*, *snakeroot*, and *pennyroyal.*

Snakeroot and pennyroyal do not appear to be very efficacious; nor does mercury in the solid form, or in its preparations, even when given in very full doses, and to the extent of causing profuse salivation, appear to be attended with any risk of abortion; but the *Juniperus sabina* has some pretensions to be considered a dangerous drug: for, in common with other irritant poisons, it has undoubtedly occasioned abortion in more than one instance, though it has failed in others, and in others, again, has sacrificed the life both of mother and child.

Closely allied to the so-called *emmenagogues* is the *secale cornutum*, or ergot of rye, a medicine which possesses the remarkable property of exciting the muscular fibres of the uterus to contraction, and is in much too frequent use for that purpose. Concerning the efficacy of this remedy, much difference of opinion exists.

Some authors have supposed that the power of the ergot is limited to the period of delivery, and to the state of full expansion and development of the uterus. This opinion seems highly improbable, and cases are certainly recorded in which this active agent produced abortion at an earlier period of gestation; and experiments on animals have shown that it is capable of producing abortion at any period. On the other hand, several cases are recorded both by Dr. Condie and by Dr. Beck, in which considerable doses of the ergot, often repeated, failed in producing abortion.

The root of a plant called the *Actea ramosa* has the reputation of being nearly as active as the ergot.

Digitalis has been named among the substances capable of producing abortion, on the authority of a case related by Dr. Campbell. The digitalis was given for dropsy; the child was still-born, and the mother died soon after. Mr. W. H. Dickinson ('Med. Chir. Trans.,' vol. xxxiv. p. 1) has shown that digitalis in such doses as from ʒſs. to ʒiſs. of the infusion, and ♏xx. to ♏xl. of the tincture, has a specific action on the uterus; and its power of producing abortion, though not proved, is to be inferred from the facts stated.

It results from all these observations on the power of medicines to produce abortion:—That there is no one medicine which can be depended on as a means of procuring abortion in women not strongly predisposed to miscarry; that, if given in doses short of those which would risk the life of the mother, they would almost certainly fail of accomplishing their purpose; that, where they do succeed, they place the life of the mother in jeopardy, and often sacrifice it; and

that, for every case in which the mother escapes, there is probably one at least in which the mother and her offspring both fall a sacrifice, and one in which the mother dies, the child remaining uninjured in the womb. The fact is, that none but *poisons*, or medicines administered in poisonous doses, can be expected to produce abortion in any case unless the predisposition to abortion is already very strong; when such predisposition does not exist, the mother is much more likely to fall a sacrifice, whilst the child remains intact in the womb, or is even born alive, than the child to be expelled and the mother to survive; in other cases both the mother and offspring will perish.

Mechanical means.—These consist either of *external violence applied to the abdomen or loins*, or of *instruments introduced into the uterus.*

External violence applied to the abdomen or loins is a sufficient cause of abortion, and cases enough are on record to prove that it is so. But it would appear that unless the degree of violence is such as to endanger the life of the mother, it is not likely to occasion abortion. "In 1811 a man was executed at Stafford for the murder of his wife. She was in the pregnant state, and he had attempted to induce abortion in the most violent manner, as by elbowing her in bed, rolling over her, &c., in which he succeeded—not only procuring abortion, but along with it the death of the unfortunate woman."* "A female in the last month of her pregnancy was struck on the abdomen by her husband. An extensive detachment of the placenta caused the immediate death of the fœtus, and that of the mother in fifty-one hours afterwards." †

Severe injuries not directly inflicted on the abdomen often fail of occasioning abortion. Thus, Madame La Chapelle mentions the case of a young midwife, who was pregnant and had a narrow pelvis; and who, with a view to procure abortion and avoid the Cæsarian section, threw herself from a height. She died in consequence of her wounds, but she did not miscarry. Mauriceau also gives the case of a pregnant female seven months gone, who to escape from a fire in her room slid down from the third story, but losing her hold from fright, fell upon the stones and fractured her forearm; but there was no abortion.

The same remarks apply to the *introduction of instruments into the womb*, as to the causes of abortion which have been already mentioned. In some instances abortion has been procured; in others, though considerable injury has been inflicted, the child has been born alive; and in all of them the mother's life has been endangered or sacrificed. In attempting to puncture the membranes, especially at the early periods of gestation, the uterus has generally been seriously, and often fatally, injured.

Sulphuric acid, in one extraordinary case, has been injected into the vagina with a view of producing abortion. The result was the most

* Smith's 'Forensic Medicine,' p. 305.

† Campbell, op. cit. p. 131.

violent inflammation of the parts, and adhesion of the os tincæ, with the formation of a dense membrane over it. After attempting delivery by incisions into the neck of the uterus, it was found necessary to perform the Cæsarian operation—and both the mother and the child died.*

The following case which occurred in the practice of Dr. Wagner, of Berlin, illustrates so forcibly the difficulty of procuring abortion in women not predisposed to miscarry, whether by medicines or by mechanical means, that it will form a very fitting conclusion to this subject.

"A young woman, seven months with child, had employed savin and other drugs with a view to produce miscarriage. As these had not the desired effect, a strong leathern strap (the thong of a skate) was tightly bound round her body. This too availing nothing, her paramour (according to his own confession) knelt upon her, and compressed the abdomen with all his strength: yet neither did this effect the desired object. The man now trampled on the girl's person while she lay on her back; and, as this also failed, he took a sharp-pointed pair of scissors, and proceeded to perforate the uterus through the vagina. Much pain and hæmorrhage ensued, but did not last long. The woman's health did not suffer in the least; and, pretty much about the regular time, a living child was brought into the world without any marks of external injury upon it."

Examination of the Female.—In cases of abortion we may be required to examine the person of the suspected female. We should be guided in such an examination by the signs already laid down at p. 59; bearing in mind that these signs will of course be less strongly developed in the early than in the later months. Before two months little dependence can be placed on these signs.

If the female dies, we may be required to examine the body, and must be guided by the same signs that exist in delivery at the full period, but which are less distinct as the period of utero-gestation is earlier.

The following is a summary of the chief points to be attended to in cases of *abortion:* The supposed product of conception must be submitted to minute and careful examination. If a fœtus has been expelled, its age must be determined by the rules already laid down.

The reputed mother, whether alive or dead, must then be examined; —if alive, we must endeavour to ascertain whether there was or was not such a predisposition to abortion as to account for its having taken place, without attributing any great efficacy to the means employed. With a view of determining whether or not such a predisposition exists, we must inquire into the general state of health of the mother before the abortion took place, and especially whether she has had previous abortions—and if so, whether they occurred at or about the same period of gestation. If the female died from the means employed, we

* This case is given in the report of M. Guerin to the Académie Nationale of Paris, and is cited in the 'Lancet,' vol. viii. p. 38.

must use the same care in examining the state of the uterus, and must observe the rules hereafter to be laid down for conducting post-mortem examinations.

Some questions of medical ethics mix themselves up with the question of abortion, as

Under what circumstances, and by what means, is it morally and legally proper to induce premature delivery? and what circumstances will justify the Cæsarian operation?

Such questions as these are easily answered. The medical man is clearly justified in resorting to any measures which promise to preserve the life of mother and child when both are threatened; and where one only can by any possibility be preserved, the female herself may use her right of self-preservation, and choose whether her own life or that of her child shall fall a sacrifice to the means recommended to be used.

INFANTICIDE.

There is no crime which meets with so much public sympathy as Infanticide, and this feeling has been largely shared by members both of the medical and legal profession. The medical man has consequently been led to take the part of an advocate where he should have been merely the man of science; while the lawyer has equally forsaken his proper sphere by setting himself up as a judge of matters with which he could have but a slender acquaintance.

This misplaced humanity, added to learning equally misplaced, has encumbered with objections, and overlaid with refined subtleties, a subject necessarily complicated.

The public sympathy for the child-murderer arose out of the extreme harshness and cruelty of a former statute (21 Jac. I. cap. 27), which virtually visited the concealment of shame with the punishment of murder. Dr. William Hunter, under the influence of that injustice, wrote, in 1783, his celebrated essay 'On the Uncertainty of the Signs of Murder in the Case of Bastard Children.' About a quarter of a century later (1803) an act was passed decreeing that women accused of infanticide should be tried by the same rules of evidence as obtain in other trials for murder; but that the prisoner, if acquitted, may be put on her trial for concealment of the birth, and, if found guilty, punished by imprisonment for a term not exceeding two years.

The provisions of this statute were confirmed by an act passed in June, 1828 (9 Geo. IV. cap. 31), which act also provides that it shall not be necessary to prove whether the child died before, at, or after its birth; but that if any woman tried for the murder of her child shall be acquitted, she may be tried for the concealment of the birth, and punished as if she had been originally put upon her trial for the concealment of the birth.

Questions of infanticide are necessarily more complicated than those

of homicide in general; for, previous to the inquiry into the means by which a child has come by its death, it is necessary to show that it has been born alive. The medical man may, moreover, be required to examine the female suspected of being the mother of the child, in order to determine whether or not she has been recently delivered.

Two classes of questions, then, may be raised in cases of infanticide; the one relating to the child; the other to the mother.

QUESTIONS RELATING TO THE CHILD.

These are the following:—

1. What is the degree of maturity of the child?
2. Was the child born alive?
3. If born alive, how long did it survive its birth?
4. How long has the child been dead?
5. What was the cause of death?

1. THE DEGREE OF MATURITY OF THE CHILD.

This question will be answered by employing the data contained in the introduction to this Chapter, viz., the length and weight, the position of the centre of the body, the proportional development of the several parts, the growth of the hair and nails, the condition of the skin, the presence or absence of the membrana pupillaris; in the male, the descent or non-descent of the testicles, &c.*

2. WAS THE CHILD BORN ALIVE?

This question involves a great number of details, and depends on the determination of many difficult and delicate points.

First, as to the legal meaning of the term *born alive*. It has been decided in more than one case, that to constitute live-birth the child must be alive after the whole body has been brought into the world; that it must have an independent circulation; but that to constitute such independent circulation, it is not necessary that the umbilical cord should be severed.

In examining the body of a child with a view to determine whether or not it was born alive, the chief point to be attended to is the state of the lungs. If we can discover in these organs signs of respiration, we establish a probability in favour of live-birth; but if there are no signs of respiration in the lungs, there is an equally strong probability that the child was still-born. But in the absence of all signs of respiration there may still be sufficient proof that a child has or has not been born alive. Hence the present inquiry consists of two parts. 1. The evidence of live-birth, independent of, and prior to, respira-

* See ante, p. 63 et seq.

tion. 2. The evidence of live-birth deduced from, and subsequent to, respiration.

The evidence of live-birth prior to respiration is either negative or positive,—negative when we discover signs of previous death within the womb; and positive when we discover injuries upon the body of the child which must have been inflicted while the blood was still circulating, and of such extent and severity that they could not have happened accidentally or been inflicted *during* the birth.

Intra-uterine maceration.—The appearances presented by a child which has died in the womb, and has there undergone maceration, are the following:—The body is shrunken and flaccid in every part, the chest and abdomen flattened, the ribs distinctly visible through the skin, the ilia prominent, the extremities attenuated. The head is soft and yielding, so that it falls flat in whatever position it may be placed. The cuticle is more or less extensively detached, and is everywhere easily separated from the true skin. On the hands and feet the cuticle is white, thickened, and wrinkled, as if from the application of a poultice. The true skin itself is more or less extensively discoloured. The abdomen, which is the first part to exhibit the change of colour, presents a mottled appearance, blending a rose and ash colour. Elsewhere the skin assumes a brownish red, without any admixture of green. The parts of generation have a deep-red colour, as have also, in a less degree, the head and face. The umbilical cord is straight and flaccid. The entire surface of the skin is covered with a soapy fluid, so that the body, when handled, slips from the grasp. On cutting into the cellular membrane it is found to be infiltrated with serum reddened by the colouring matter of the blood, and to contain in parts, especially in the scalp, a substance which Orfila has aptly compared to gooseberry jelly. The periosteum is easily detached from the bones of the cranium, which are loosely united, and move easily the one upon the other. The several cavities are filled with an abundant sero-sanguinolent fluid; and the viscera are tinged throughout of a reddish-brown colour, at the same time that their minute structure is very distinctly displayed.

These appearances are more or less strongly marked, as the child has lain a longer or shorter time dead within the womb. They are quite distinct from the effects of putrefaction, whether in air or water, and the odour of putrefaction is entirely wanting. When developed in a marked degree it is impossible to mistake them for those due to any other cause; but if the death of the child took place only a short time before its expulsion from the womb they would not be present. In such a case the absence of all traces of respiration on the one hand, and of marks of violence accompanied with copious effusion of blood, on the other, would prove that the child was still-born.

The single case in which, anterior to, and independent of, the establishment of respiration, we may state that a child has been born alive, is, when we find marks of violence on the body so severe that

they could not have been inflicted during the birth, and attended with hæmorrhage so considerable that it could only have occurred while the blood was still circulating. Thus Devergie relates a case of the murder of an infant that had not respired, which was proved by the existence of extensive wounds and marks of great violence on the head, with copious effusion of blood.* To justify a positive opinion in such a case, the loss of blood must be large; for a severe wound inflicted on a plethoric infant after the circulation had ceased, might be attended with considerable hæmorrhage.

There are two cases, then, in which, independent of, and anterior to, respiration, we may decide the question, "was the child born alive?" in the one negatively when we find the marks of intra-uterine maceration, in the other affirmatively, when we discover injuries which, from their extent and severity, must have been inflicted after the birth of the child, and while the blood was still circulating.

But the cases in which we can obtain evidence of live-birth before respiration must be extremely rare, as few children in whom the blood is still circulating are born without respiring, at least imperfectly.

In the great majority of cases, therefore, the evidence of live-birth must be sought for in the lungs, proof of respiration being the first link in the chain of evidence that the child was born alive.

In order to prove that a child was born alive we must first show that respiration has taken place; and then that the child breathed after the birth. For in order to prove that the child has been *born alive*, it will not suffice to prove that it has breathed, for it may have breathed during the birth and yet have perished before the delivery was complete.

HAS RESPIRATION TAKEN PLACE?

The best evidence of respiration is the change which it produces in the external appearance of the lungs; and, were it not that inflation gives rise to the same change, a mere inspection of the lungs would supersede all other tests. As it is, it serves to establish the alternative of respiration or inflation when all other means fail.

Lungs which have neither respired nor been inflated, are of a uniform texture throughout, and resemble both in colour and consistence the adult liver. Their surface is marked by slight furrows, which obscurely denote the division of the lobules. When the lungs are full of blood, these slight furrows are scarcely, if at all, visible; but when those organs are comparatively empty, the furrows are more distinct, and are still more strongly marked in the lungs of the fœtus which has undergone intra-uterine maceration. The lungs are also sometimes found studded with small circular melanotic spots.

The effect of respiration or inflation varies according to the degree of either. The smallest quantity of air serves to develop some of the

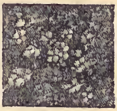
* 'Annales d'Hygiène,' May, 1837.

air-cells on the surface of the lungs; and these developed air-cells form the best proof of the admission of air in one of these two ways. The right lung, and especially the edges and concave surface of its upper lobe, admit the air most readily: it is here, therefore, that the first effects of inflation or respiration must be looked for.

The air-cells thus developed present a highly characteristic appearance. If the lungs are fresh and filled with blood, their position is marked by brilliant vermilion spots; if the lungs contain less blood, or if they are examined some days after the death of the child, the spots are of a lighter colour; and in children who have survived their birth some days, they have very nearly the colour of the healthy adult lung.

The form and arrangement of the cells are not less characteristic than their colour: they are angular in shape, are not perceptibly raised above the surface, and are obviously situated in the substance, though near the surface, of the lung. The grouping of the cells is generally irregular, but occasionally, as Devergie observes, they are found in groups of four, arranged in a perfectly regular and symmetrical manner. The ordinary appearance and grouping of the cells is represented in the annexed wood-cut taken from a coloured drawing of fœtal lungs in which respiration had been imperfectly set up.

Fig. 5.



Another appearance which I have once seen the air-cells present, is that of a group of small globules, like millet seeds, arranged closely side by side, and on the same level.

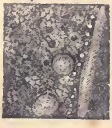
The only appearances on the surface of the lungs with which these developed air-cells might by possibility be confounded, are, 1, the small circular melanotic spots already mentioned; 2, small round spots of blood thrown out upon the surface; and, 3, air-bubbles, the product of putrefaction. The first two appearances may be at once distinguished by the perfect roundness of the spots, the entire absence in them of anything resembling a developed texture, and their characteristic colour, the melanotic spots being black, and the spots of blood deviating very slightly in colour from that of the surrounding portions of lung. These spots, therefore, can occasion no difficulty.

The appearance of the air-bubbles produced by putrefaction is, if possible, still more characteristic. The air collects on the surface, and between the lobes of the lungs, either in detached globules, the size of peas, rising above the level of the surrounding lung, or as a string of minute vesicles not unlike a fine mercurial injection beneath tissue-paper. The air is evidently contained in the cellular membrane connecting the pleura with the surface of the lung, and its true situation is often pointed out by a small globule seated upon a larger one. If these appearances were not sufficient to distinguish air, the product of putrefaction, from air contained within the air-cells, it would suffice to pass the finger over the surface of the lung. The air follows the

pressure of the finger, and is dispersed, and a little stronger pressure effaces the bubbles, and will even break down the larger globules. No amount of pressure so applied will force the air out of the air-cells, or in any way alter their appearance.

Some authors, as will be presently more fully stated, have spoken of an emphysema of the fœtal lungs, as giving rise to some difficulty in applying the hydrostatic test; but it will be shown that this so-called emphysema is merely an incipient process of putrefaction, giving rise to precisely the same appearances, and admitting of the same ready discrimination, as the more ordinary results of putrefaction. The subjoined engraving is as faithful a representation as it is possible to give, without colour, of the several appearances described in the text. With the exception of the large air-bubbles, which are taken from another subject, all the appearances were present on the same limited space of the surface of the lungs. The air-cells are recognized by their peculiar shape and grouping; the round dark spots are melanotic, the fainter spots are effused blood; the string of small light round dots, and the two large circular spots, are air-bubbles.

Fig. 6.



It can scarcely be necessary to offer a caution against confounding with the developed air-cells that change of colour which takes place on the surface of fresh fœtal lungs from the contact of air. The change of colour is the same in both cases, but the mere contact of air with the surface of the lungs does not alter the texture of the organ in any way.

The appearance of the developed air-cells is, therefore, quite characteristic. It furnishes undeniable proof either of respiration or of inflation, and is the only lung-test to which no serious objection can be offered.

Considered as a test, or sign, of the admission of air into the lungs in one of these two ways, it is also as delicate as it is simple; for it detects the smallest possible quantity of air introduced into the lungs, a quantity much too small to have any appreciable effect on the specific gravity either of the entire lung, or of the portion of the lung into which it has been introduced. I have repeatedly detected at a glance the existence, in the superficial air-cells, of a quantity of air which was insufficient to render the smallest fragment of the lung buoyant; and I have never found these signs of respiration absent in any case in which a child was stated to have breathed, though for the shortest space of time. In one case in which it was reported that the child had given only three distinct gasps, the effect of respiration was obvious, at the first glance, in the bright vermilion-coloured groups of developed air-cells scattered over the surface of the right lung. This sign, therefore, succeeds where the hydrostatic test fails.

If a different appearance were produced in the air-cells by respiration and inflation respectively, and we could infallibly distinguish the

one from the other, there would be no need of any other lung-test; and if it could be made to appear that all the other tests which have been proposed fail in effecting this most desirable object, then all those tests would cease to have any claims upon our attention.

Devergie,* after stating, correctly enough, that an attentive examination of the bodies of several infants had enabled him to distinguish, *à priori*, and without any other research, lungs belonging to a still-born infant from those of an infant which had breathed; and also to determine whether the air had dilated all parts of the lungs, or merely certain portions of those organs, adds, that "in *many* cases he could determine whether the distension of the lungs with air was the effect of respiration or of insufflation." In the case of air introduced by respiration, Devergie states that there is a minute injection of capillary vessels on the surface of the air-cells, which injection does not take place in the case of inflation. This distinction may be well founded, but it deals with parts so extremely minute, and, according to the author's own statement, is to be relied on only in *many*, but not in *all* cases, that it may be fairly set down as unfit for medico-legal use. I have not myself observed such a difference between the effects of inflation and respiration as to pretend to be able in this way to distinguish the one from the other.

Developed air-cells, then, form the best, and the only necessary proof, of the admission of air into the lungs; and they are to be found in every case of respiration or inflation, however limited in extent, or slight in degree.†

The number of the air-cells, and the degree to which they are developed, is, moreover, a measure of the extent to which these processes have been carried. When respiration is complete, the lungs present the spongy, crepitant character of adult lungs, and differ from them only in having a more rosy colour.

Before proceeding to the consideration of the other lung-tests, it is necessary to premise that respiration is not a sudden, but a gradual process; that it is rarely, perhaps never, completed in a few respirations; that it very often remains incomplete and partial after many hours, days, or even weeks; and that in some grown-up persons portions of the lungs are even believed to remain permanently in their fœtal state. In by far the majority of cases of infanticide, therefore, we shall have to deal with lungs in which the process of respiration has been very incompletely set up. This fact increases the importance of a sign which stands us in stead where, as will be presently shown, every other test may fail.

But the admission of air into the air-cells of the lungs is not the only effect of respiration. As a general rule, this change is accom-

* 'Médecine Légale,' vol. i. art. Infanticide.

† It is strange that this simple sign of respiration should have been so often overlooked. Cruveilhier, in his 'Morbid Anatomy,' depicts the bright vermilion air-cells as a disease of the fœtal lungs.

panied by an increased afflux of blood, leading, as a natural consequence, to an increase of weight in the lungs themselves, and an increase in their weight as compared with that of the body. This increase of weight, absolute and relative, has been made the basis of two lung-tests.

The absolute Weight of the Lungs.—This test of respiration rests upon the supposition that "the arteries and veins of the lungs of a fœtus, which have not respired, are empty, and in a state of collapse," whilst after respiration they become more or less filled with blood. This erroneous statement of Foderé has been corrected by Orfila and Devergie. That it is a gross mistake, I have had many opportunities of proving; for I have examined lungs which had breathed, and found them almost destitute of blood; and have repeatedly met with lungs that have never admitted air, or which presented only a few groups of developed air-cells, but yet were gorged with blood in every part.

The received estimates of the weight ot the lungs before and after respiration were in accordance with these erroneous assumptions. The lungs of mature children before respiration were stated to weigh one ounce, or 480 grains, and after respiration two ounces, or 960 grains. How remote these estimates were from the truth, the following averages, founded upon upwards of 400 observations on mature children, will serve to show:—Still-born, 874 grains; children who had survived their birth one month or less, 1072 grains. The observed weight, therefore, in still-born children is nearly double the rude estimate of authors, and the increase after respiration, instead of being equal to the original weight, is less than one-fourth. These averages differ too little from each other to admit of practical application in a court of law: the extreme figures are still more conclusive, as the comparison instituted in the following table will show.*

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
510	510	694	—
520	—	703	—
550	546	713	726
—	562	744	746
586	590	—	774
630 (two)	—	—	861
632	—	—	920
640	—	1054	1000
647	—	—	1173
658	—	—	1189
666	—	—	1203
683	675	1480	—
687	—	1950†	—

* For the particulars of these observations, which are all taken from English sources, see 'Lancet,' Oct. 1, 1842. The case marked † has been subsequently added. It is given on the authority of Dr. A. Taylor.

	Before Respiration.	After Respiration.
Maximum .	1950	1203
Minimum .	510	510
Mean .	769	820

This table speaks for itself: it shows in a striking manner the limited application of the absolute weight of the lungs as a test; for, out of 34 cases, there is not a single one in which we could have stated, by means of this test alone, that respiration had, or had not, taken place; while, in two instances, the great weight of the lungs would have led us to infer respiration, though the children were still-born.

As in the great majority of cases of alleged infanticide the lungs of the child, if it has breathed at all, are found to contain but little air, it is important to determine the effect of imperfect respiration in increasing the weight of the lungs. The following is the average result of a considerable number of facts:—Still-born, 874 grains; imperfect respiration, 988 grains; perfect respiration, 1195 grains.

The effect of imperfect respiration, then, is to increase the weight of the lungs by about 100 grains, or one-eighth of their original weight.

The mean weight of the lungs after different durations of respiration is as follows:—Still-born, 874 grains; less than one hour, 918 grains; twelve hours, 853 grains; one day, 1000 grains; one month and less, 1072 grains.

Hence the duration of respiration for one hour adds less than 50 grains to the weight of the lungs, which is increased by only 126 grains when respiration has lasted one day. If additional evidence were required of the uselessness of this test, it might be found in a comparison of the weight of the lungs in two children born alive in whom the weight of the body was the same. In the one case the lungs weighed 1544 grains, and in the other 494, the one being more than three times as great as the other.

It appears, then, that the difference between the absolute weight of the lungs before and after respiration, and especially after imperfect respiration, or respiration lasting only for a short time, is much too slight to be used as a test; and that the inference drawn from a comparison of average weights is fully confirmed by a comparison of the extremes.

This test, moreover, is rendered unnecessary by the mere inspection of the lungs; unless, indeed, it could be shown that the absolute weight of the lungs promises to assist us in distinguishing respiration from inflation. This, though it has been recommended for that purpose, it does not do; for as it fails in distinguishing the lungs of the still-born from those which have respired, it must also fail in distinguishing lungs that have breathed from those that have been inflated: for inflated lungs are, as to the blood which they contain, in the condition of fœtal lungs.

Ploucquet's Test, or *the ratio of the weight of the lungs to that of the body*.—Before entering upon an examination of this test it is ne-

cessary to premise, that the bodies of still-born children are heavier by about one-third than the bodies of children born alive; that the body of the male is heavier than that of the female; that the proportion which the weight of the lungs bears to that of the body decreases as the weight of the body increases; and that the weight of the lungs is subject to much greater variation than that of the body.

This test is a good example of the futility of all conclusions drawn from a small number of facts. Ploucquet himself making use of three facts, only two of which were strictly comparable, obtained the proportion before respiration, of 1 to 70; after respiration, of 1 to 35. The more numerous facts collected by subsequent observers have greatly modified these proportions, and the following statements will, it may be hoped, serve to consign the test to oblivion. The averages drawn from more than 400 observations on mature children are as follow:—Still-born 1:57, instead of 1:70; children who have lived one month or less 1:38 instead of 1:35. The extremes, which, as before observed, are the values really required for practical purposes, are shown in the following table.

Before Respiration.	After Respiration.	Before Respiration.	After Respiration.
1:91	—	1:54	1:55
1:82	—	1:51 (two)	1:52
1:74	—	1:49	1:49
1:71 (two)	—	—	1:48
1:70	—	—	1:46
1:67	1:65	1:45	1:45
1:61	1:61	—	1:44 (two)
1:60	—	—	1:41
1:59	1:59	—	1:39
1:57 (three)	1:56	1:21	

	Before Respiration.	After Respiration.
Maximum .	1:21	1:39
Minimum .	1:91	1:65
Mean . .	1:60	1:50

The results of this table differ somewhat from those already obtained in the case of the absolute weight of the lungs; for in 7 cases out of 33 there is certainly a probability, derived from the low ratio obtained, that respiration had not taken place; but, on the other hand, there is one case in which, relying upon this test, we should have mistaken a still-born child for one that had breathed. The value of our conclusion must, moreover, depend, as in the case of the absolute weight of the lungs, upon an assumption that we have found the true limits both before and after respiration.

The following are the mean proportions after different durations of respiration:—Still-born, 1:57; less than one hour, 1:51; 12 hours, 1:53; 1 day, 1:48; 1 month, or less, 1:38.

The difference between the several proportions is here extremely small; certainly much too small to justify the employment of the test in cases of imperfect respiration, in which alone such a test can be required.

If further proof were required of the futility of this test, it might be found by comparing the ratio of the lungs to the body in two cases in which the weight of the body was precisely the same. Thus, to take only one instance: the weight of the body being in each of two children born alive 32,436 grains, the lungs bore to the body in the one case the proportion of 1 to 21, in the other of 1 to 66; the one ratio being more than three times as great as the other. Precisely the same remarks, too, apply to this test as to the absolute weight of the lungs. Simple inspection would render it superfluous even if it were useful; and it cannot serve to distinguish inflation from respiration.

Both the static lung-tests should, therefore, be allowed to fall into disuse as alike unsafe and unnecessary.

The Hydrostatic Test.—This is without exception the most interesting and important test ever proposed for the determination of a medico-legal question; interesting from the many controversies to which it has given rise, and important on account of the purpose to which it is applied, and the high value formerly assigned to it.

That this test may be understood, it must be premised, that though, when first proposed, it was erroneously considered a test of live or still-birth, it is merely a test of respiration; the question, when or where did respiration take place, being consequent on the determination of the fact of respiration. It is necessary further to premise that the Hydrostatic Test has undergone several modifications since it was first proposed towards the end of the seventeenth century. Originally, and till a comparatively recent period, it consisted in placing the lungs, with or without the heart attached, entire in a vessel of pure water of the temperature of about 60°. This rough test was first modified to the extent of dividing the lungs into several pieces and experimenting with those pieces as with the entire lungs. The test, as now performed, consists in first immersing the several portions of the lungs in water, and then applying to them the subsidiary test of pressure. It will be presently seen that the objections urged against the hydrostatic test apply chiefly to the test as originally performed; and that this additional test of pressure removes at least one objection, though it leaves others in full force, and opens an important inquiry as to the distinction between the effects of respiration and inflation.

In examining the hydrostatic test, it will be convenient to consider, in the first place, the value of the test as originally performed, including the addition subsequently made of dividing the lungs into several portions, but without submitting them to pressure; and with

the distinct understanding that it can in no case be a test of live-birth, but only of respiration. A supporter of the hydrostatic test would assert on its behalf, that, if the lungs, whether entire or divided into portions, when placed in a vessel of water sink to the bottom, respiration has not taken place.

To this assertion there are two objections. 1. That respiration may have taken place, and yet the entire lungs, as well as the several parts into which they have been divided, may sink in consequence of disease. 2. That respiration may have taken place, but to so limited an extent, or in so imperfect a manner, that both the entire lungs and every portion of them, though perfectly healthy, containing only the ordinary quantity of blood, and presenting no unusual appearance, may nevertheless sink.

Now, in examining the first objection, it must be borne in mind that disease may exist before respiration or supervene after it. If a disease existing before birth affect the whole of both lungs, it is obvious that respiration cannot take place; but if it affect only certain parts of the lungs, there is nothing to prevent the healthy portions from receiving air, and those portions of the lungs would float, provided the quantity of air admitted into them were sufficient to render them buoyant. If, on the other hand, the disease supervene after respiration, it is not probable that it would proceed to such an extent as to consolidate the whole of both lungs. Hence some portions would be found to float. On either of the foregoing suppositions, that is to say, whether the disease occurred before respiration or supervened upon it, the cases must be extremely rare in which the objection on the score of disease would be valid.

Without having recourse to authorities, it may be safely stated, that disease occurring after respiration rarely, if ever, affects the whole of both lungs; certain portions, therefore, will remain free from disease, and, provided respiration has been completely performed in those portions, they will, by their buoyancy, at once remove the objection. It will not, perhaps, be safe to deny the possibility of the lungs being so extensively affected by pneumonia as that no part of them shall remain buoyant; but the event must be of extremely rare occurrence, and the objection will almost never find place. When the disease is partial, whether it occur before birth or after respiration, the objection can hold good only in those cases in which respiration has been so imperfectly established in the healthy portions of the lung as not to render any one of those portions buoyant. In such cases the first objection merges in the second; for if lungs healthy in all their parts may respire without becoming buoyant, it follows that lungs which have only certain parts of their structure in a sound state may receive air into those parts in a quantity too small to cause them to float. If it can be shown that lungs healthy in all their parts may, in spite of respiration, sink when placed in water, it will follow that lungs which are only partially healthy may also sink, though

respiration have taken place. This leads to the second objection, viz. :—

That respiration may have taken place, but to so limited an extent, or in so imperfect a manner, that neither the entire lungs, nor any portion of them, though perfectly healthy, containing only the usual quantity of blood, and presenting no unusual appearance, shall float. A single case, reported by Dr. Alfred Taylor,* will suffice to prove the validity of this objection. The child was a female twin, weighing little short of five pounds and probably nearly mature. "The substance of the lungs was healthy, of a deep Modena-red colour, with here and there patches of a somewhat lighter hue. There was no crepitation under the knife, nor was there any mark of congestion; for no more blood followed the incisions than is ordinarily witnessed in dividing the lungs of the fœtus." "The lungs were separately placed in water; but they both sank with equal rapidity. Each lung was then cut into fifteen pieces." "The pieces of the two lungs having been kept apart, were placed in water separately; and it was remarked that every portion sank rapidly to the bottom: and on compression below the surface of water, no bubbles of air escaped." This child had survived its birth twenty-four hours.

This single case is sufficient to establish the validity of the objection now under consideration; but it is by no means unique, for similar instances have been reported by Bernt, Remer, Orfila, Daniel, Schenk, and Osiander, which cases are quoted in the Essay from which the foregoing fact is taken. Billard meeting with some of these cases was led into the strange error of supposing, that children may survive their birth for hours, and even days, without breathing.† I have myself repeatedly examined lungs in which the process of respiration had been very imperfectly set up in several portions of one or both lungs, and yet only one or two of the several parts into which the lungs were divided floated when placed in water; but I have not met with any instance in which every portion of both lungs sank.

The objection, then, to the statement that the sinking of the lungs, whether entire or divided into several portions, is a proof that respiration has not taken place, is a sound and valid objection to the hydrostatic test in its original form; and the objection of course applies equally to lungs healthy in all their parts, and to those which have only some portions of their structure free from disease.

Let it now be supposed that the entire lungs, or any one of the several portions into which they have been divided, float when placed in water; and that this buoyancy of the whole lung, or of its parts, is asserted to be a proof that respiration has taken place. This assertion would be met by three distinct objections. The buoyancy may be due, not to respiration, but 1. to Emphysema; 2. to Putrefaction; or, 3. to Inflation. The first objection, that the lungs may float in con-

* 'Guy's Hospital Reports,' No. v. case 4.

† 'Maladies des Enfans,' title Viabilité.

sequence of emphysema is easily disposed of. The term emphysema, in its usual acceptation, means an enlargement or rupture of the air-cells, which enlargement or rupture can only be produced by air introduced through the air-tubes in the process of respiration, or by inflation. Now, air so introduced into the lungs will expand the air-cells so as to furnish, independent of the emphysema itself, distinct proof that the child has breathed. On the other hand, if the emphysema were caused by inflation, the first objection would become identical with the third. But the emphysema spoken of as an objection to the hydrostatic test, is an emphysema of a different kind, and is alleged to be caused by air generated in the lung by some peculiar action of its tissues. Dr. Cummin* says: "It sometimes happens that infants suffer violence in the birth; the labour, perhaps, being tedious, and the mother malformed. The sides of the chest may be so pressed against the substance of the lungs as to do those organs injury; they become inflamed and puffy, containing air in large vesicles on their surface, and this is what some authors call emphysema." Lécieux also states that in extracting an infant by the feet, he often found that a part of the lungs floated, though the child had certainly not breathed, and even died in the course of the delivery. He could not attribute this accidental buoyancy of the lungs to putrefaction, because the infant did not present the characters of putrefaction, and he examined the body a short time after the extraction; but as we sometimes see a wound or a bruise, especially on the head, accompanied by an emphysematous swelling, it appeared to him that in this case, during the extraction of the fœtus, the lungs suffered a sort of contusion; that an effusion of blood took place into their tissue, which by undergoing a change gave rise to the formation of some bubbles of air, and in this way produced the buoyancy of a part of the lungs. This explanation appeared to him the more probable, inasmuch as the lungs had a brownish violet tint.†

That it is not necessary to resort to this explanation of the formation of gas in the lungs, the following fact will suffice to prove.

During the winter of 1840, I examined the body of a mature still-born fœtus, within forty-eight hours after its extraction by instruments. There was not the slightest trace of putrefaction in the lungs or in any other part of the body; there was no change of colour, no softening of tissues, no putrefactive odour, and, with the exception of a vesicle the size of a pea on the surface of one of the lungs, no formation of gas. The lungs, which were gorged with blood, were extracted, put into a gallipot, and carried in the pocket about two hours; at the end of which time their entire surface was found studded with vesicles, some of them as large as a pea, and others smaller than a pin's head.

Here, then, in the course of two hours a very large quantity of gas

* 'The Proofs of Infanticide Considered,' by William Cummin, M.D. p. 61.
† Lécieux, 'Considérations Médico-légales sur l'Infanticide.'

was developed, though the lungs had certainly undergone no injury in the birth, and no single sign of putrefaction could be detected.

This incipient process of putrefaction, for it is nothing less, is not limited to the lungs, but may occur in effusions of blood on the brain (of which I have seen two examples) and in other parts of the body, especially in parts containing an unusual quantity of blood. When it occurs in the lungs they are usually congested, or the seat of pulmonary apoplexy which is apt to occur in children delivered after tedious labours, or extracted by instruments.

The considerations now advanced seem, therefore, to justify the opinion that this so-called emphysema is nothing more than an incipient process of putrefaction. Hence the first objection to the floating of the lungs as a test of respiration merges in the second; and instead of three objections we have only two; the formation of air in the cellular tissue in consequence of incipient or advanced putrefaction; and Inflation.

1. Of the formation of air in the cellular tissue of the lungs in consequence of putrefaction. The possibility of the lungs floating in water in consequence of putrefaction has been called in question; but there is no sufficient reason to doubt that the lungs may become buoyant from this cause.

Some experiments which I made during the winter of 1839, will serve to illustrate the origin of the opinion that putrefaction will not cause the lungs to float. In some instances the lungs of still-born children, when placed in water, as soon as they began to give out a putrefactive odour, gradually rose to the surface, where they remained for many days, and then slowly sank to the bottom. In other instances, large air-vesicles were formed on the surface of the lungs, but not in sufficient number to render them buoyant; whilst in others, again, though the lungs gave out a strong putrefactive odour, there was no development of air-vesicles, and no tendency to rise to the surface; nor did they ever become buoyant either in the water in which they had stood, or in clear water. This remarkable difference may perhaps be explained by the quantity of blood contained in the lungs, putrefaction being more readily set up when the quantity is considerable.

There is no longer, therefore, any room to doubt that gases developed in the various stages of the putrefactive process may cause lungs which have not breathed to float. This objection to the hydrostatic test, as originally performed, is, therefore, a valid objection.

2. Of Inflation. The objection that the lungs may be rendered buoyant by inflation, is also valid, as the possibility of inflation being effectually performed to the extent of causing the lungs to float is universally admitted.

From what has been stated, it follows that to the Hydrostatic Test, as originally and till a comparatively recent period performed, and used merely as a test of respiration, there are four valid objections,

that is to say, two to the sinking of the lungs as a sign that respiration has not taken place, and two to the floating of the lungs as a proof that it has. To the sinking of the lungs as a proof of still-birth there are the objections of disease and imperfect respiration, and to the floating of the lungs as a proof of respiration there are the objections of putrefaction (in its several degrees and stages) and inflation.

Such is the value of the hydrostatic test, in the sense in which that term was used up to the period of the introduction of pressure as an auxiliary test.

The Hydrostatic Test as modified by the addition of Pressure.—The mode of applying pressure is not very material, provided it be not carried to the extent of destroying the texture of the lung. For some purposes the pressure of the finger and thumb under water is sufficient; but if stronger pressure be required it is best effected by placing the fragment of lung in a clean cloth, and, by the aid of an assistant, twisting the two ends of the cloth opposite ways. It can rarely be necessary to carry the pressure beyond this point, though in some experiments to which allusion will presently be made, the fragments of the lungs were submitted to strong pressure by treading the cloth which contained them under foot.*

A supporter of the hydrostatic test, in this its modern signification, would assert, on its behalf, that if the lungs, both entire and divided into several portions, when placed in water, sink, both before and after being submitted to pressure, ~~that~~ respiration has not taken place. The objections to this assertion are the same which apply to the earlier test, viz., disease and imperfect respiration, with this difference, however, that portions of lung containing a large quantity of blood and too little air to render them buoyant, might possibly become buoyant in consequence of a portion of the blood being forced out by the pressure. Hence the sinking of the lungs after the application of pressure affords a stronger reason for supposing that respiration has not taken place.

On the other hand, supposing the several portions into which the lungs have been divided, to float both before and after being submitted to pressure, and it is asserted that this buoyancy of the lung is a proof of respiration, do the two objections urged with success against the earlier test, viz., putrefaction and inflation, hold good here also?

The objection on the score of putrefaction falls at once to the ground; for very moderate pressure of the fingers will expel the air generated by putrefaction, and cause the lungs to sink. It only remains, therefore, to consider the force of the objection, that inflation may cause the lungs to float.

* Mr. Jennings of Leamington, after applying pressure in the manner now recommended, and subsequently by means of weights, kneaded the several portions of lung in the palm of the left hand with the thumb of the right. 'Transactions of the Provincial Medical and Surgical Association, 1834.'

That air artificially introduced into the lungs will render them buoyant, there can be no doubt; but whether the application of pressure will serve to distinguish the buoyancy which is due to respiration from that due to inflation is a question that demands very careful consideration.

The addition of pressure to the old form of hydrostatic test was first proposed by Béclard, and was introduced into practice in this country by Dr. Alfred Taylor,* and Mr. Jennings,† both of whom employed it as a diagnostic mark. The former concludes from repeated experiments, "that air, introduced by artificial inflation, may, under all circumstances, be expelled by compression, if the experiment be properly performed, and the pressure continued a sufficient length of time."‡ Mr. Jennings states, that "air introduced into the lungs, by artificial inflation, may be expelled by pressure, so that the lungs will sink in water," and on the other hand, that "after respiration, the air cannot be expelled from the lungs without completely breaking down the structure of every part of the organ. Any part, however small, not thus broken down, will continue to float."

The value of this test can be decided only by an appeal to facts. Now it is admitted by Dr. Taylor, on the authority of Case III. in the Essay already cited,§ "that air, from respiration," (imperfect respiration,) "may, by very moderate pressure, be forced out from divided portions of the organs;" and, on the authority of Case II., "that there are no satisfactory means of distinguishing artificial inflation from feeble respiration." Schmitt also reports a case in which the middle lobe of the right lung alone floated, and that imperfectly, but it sank again when forcibly compressed. The child had lived twenty-four hours, and artificial inflation had not been used.||

This test of pressure, then, does not distinguish imperfect respiration from imperfect inflation. On the other hand, some experiments which I made in the year 1841 prove that lungs completely distended by inflation cannot be made to sink by a degree of pressure short of that which destroys the texture of the lung; and that lungs so distended with air differ from those which have breathed completely only by requiring somewhat more pressure to make them sink.

As this statement is important, an account of one of these experiments, in the very words in which it was described from notes made at the time, is subjoined.

"I took the lungs of a child two months old who had died of marasmus, and the lungs of a fœtus, still-born, at eight months. I inflated the fœtal lungs completely, and in doing so ruptured the air-cells, and produced emphysema over the entire surface, so that

* 'London Med. and Phys. Journal,' Nov. 1832, and Jan. and May, 1833.
† 'Trans. of Prov. Med. and Surg. Association for 1833.'
‡ 'Guy's Hospital Reports,' No. v.
§ The child survived six hours, and breathed very imperfectly.
|| Schmitt, 'Neue Versuche,' &c. 93rd observation, p. 217.

when I ceased to inflate them the lungs rapidly collapsed. I then took one lobe from the lung of either body, and, placing them together in a cloth, submitted them, by means of an assistant, to strong pressure. Both portions still retained their buoyancy. I next stood with my whole weight on the cloth which contained them, and repeatedly stamped upon them, but still both floated though their structure was almost destroyed. I then took a portion from the lungs of both children, distinguishing the lung which had breathed by the darker colour of its central portion, placed them both together in the same cloth, and proceeded as before. After applying pressure by twisting the cloth strongly, both pieces continued to float; they retained their buoyancy even after they were trodden upon, and it was not till they were pounded with the heel, and their structure thoroughly broken up, that the inflated portion sank: the portion of the lungs which had breathed still floated, though imperfectly. On pounding this portion of lung a second time, this likewise sank to the bottom. A second and a third experiment led to the same result, the inflated portion of lung sinking after a *less* degree of pressure than the portion which had breathed, but the structure being in both portions broken up before their buoyancy was destroyed." Another series of experiments was attended with the same resnlt.

If, in these experiments, it had happened that a degree of pressure, short of that required to break down the structure of the lung, had caused the inflated portions to sink, while it was necessary to destroy the structure of the portions which had breathed before they could be made to sink, we could understand how *pressure* might become a means of diagnosis: but as the only difference is the degree in which the structure of the lung is broken up, and as, in any given case, we shall have to examine a portion of lung separately, and not side by side with one which we can take as a standard of comparison, it is obvious that this test of pressure is not applicable to medico-legal purposes.

It has been objected to these experiments that, having been made upon lungs inflated out of the body, their results do not admit of application to lungs inflated within the body. This objection, of which it is difficult to see the force or validity, has happily been obviated by experiments upon lungs successfully inflated within the body. Two such cases, of which one was reported in the 'Medical Times,' November 30, 1844, were communicated to the author by Dr. Henry Browne, of Manchester, and two similar cases by Dr. F. J. Hensley, were published in the 'Medical Times,' February 8, 1845. In all these cases the children were still-born, and the lungs were extensively inflated; but they could not be made to sink by pressure till their structure was broken up. The report of Dr. Hensley's cases is enriched by some valuable practical comments by Dr. Arthur Farre, with directions for inflating the lungs of still-born children.

The only objections, then, to the value of the hydrostatic test as perfected by the addition of pressure, are three :—1. The lungs may sink, and yet the child to whom they belong have breathed, inasmuch as respiration may have been too imperfect to render any portion of the lungs buoyant. 2. The lungs may sink though respiration have taken place, inasmuch as disease may have rendered them specifically heavier than water. 3. The lungs may float, and yet the child may not have breathed, inasmuch as inflation may render them buoyant, and pressure may fail to distinguish this effect of inflation from that of respiration.

In addition to the static and hydrostatic lung-tests, the following tests of respiration have been proposed.

Changes in the Size and Shape of the Chest.—The chest before respiration is stated to be small, narrow, and flattened ; after respiration larger, and rounder. This test is not wanted in cases of complete respiration, while in imperfect respiration the presumed changes do not occur. It is unnecessary in the one case and useless in the other.

Change in the Position of Diaphragm.—The diaphragm, before respiration, is stated to be arched and to rise high in the chest; after respiration, to be flattened and depressed. This sign is open to the same objection as the foregoing.

Changes in the Volume of the Lungs.—The lungs are stated to be larger after respiration than before ; this increase of size being dependent partly on afflux of blood, and partly on the admission of air. The uselessness of this test will be inferred from what has been already said of the static lung-tests. It also is not wanted when respiration is perfect or extensive, and it is useless in that imperfect respiration by which, as has been already shown, the lungs are not materially increased in size either by the afflux of blood or the admission of air.

Changes in the Position of the Lungs.—Before respiration the lungs lie far back in the chest, leaving the thymus and pericardium uncovered, and presenting sharp edges; after respiration they project forwards, seeming to fill the chest, nearly covering the thymus and pericardium, and having their edges rounded. This is a description of fœtal lungs and of those which have fully respired ; but the description is not applicable to cases of imperfect respiration ; for, in all the points now specified, fœtal lungs closely resemble those that have breathed imperfectly.

Changes in the Consistency of the Lungs.—Before respiration the lungs are as dense as liver ; after respiration, spongy and crepitous. When the lungs are found spongy and crepitous, they have, of course, received air; but that air may have been either inflated or respired. In cases of extremely imperfect respiration, there is no change in the lungs in this respect beyond the limits of the developed air-cells.

Weight of the Liver compared with the Weight of the Body.—After respiration a part of the blood which had circulated through the liver is diverted to the lungs. The liver, therefore, loses weight. Professor Bernt, of Vienna, availed himself of this fact to encumber the subject of infanticide with another useless test. All the objections already advanced against the static lung-tests, and all that might be urged against any test whatever, apply to this. Orfila took the pains to submit the value of the test to experiment, and found that the ratio of the liver to the body before respiration was 1 to 19; after imperfect respiration, when alone, if ever, such a test is wanted, 1 to $19\frac{5}{6}$; after complete respiration 1 to $17\frac{5}{6}$.

To all the foregoing tests, then, there is one simple objection,—when respiration is complete they are unnecessary, and, when respiration is imperfect, useless; and they do not distinguish inflation from respiration, which is the only distinction really required beyond that obtained by the first glance at the surface of the lungs.

The refinements which some German authors have endeavoured to introduce into the hydrostatic test, by means of balances and graduated jars, like the tests now mentioned, may be safely consigned to oblivion.

A careful examination of the lungs themselves is the best, and only necessary means of determining whether or not the lungs have received air through the air-passages. If the air-cells are found developed we have certain proof of respiration or inflation, and the number of cells so developed is the best measure of the extent to which those processes have been carried. The eye will detect these signs of the admission of air into the lungs where the quantity admitted is too small to render any portion of their texture buoyant. This sign, therefore, succeeds when the hydrostatic test fails.

The practical directions necessary for determining the question of respiration are, therefore, very simple. Proceed at once to extract the lungs, taking care merely not to injure their texture, or that of the surrounding organs: examine carefully the surface of the lungs, and if that surface is found of a uniform colour, and the substance of a uniform firm texture like that of the adult liver, respiration has not taken place; but if the surface is found mottled with spots of a bright vermilion, or of a rose colour, and these spots contain developed air-cells, then respiration or inflation has taken place.

It appears, then, that the only real difficulty which we encounter in ascertaining whether a new-born child has, or has not, breathed arises out of the resemblance of the effects of inflation to those of respiration. This difficulty, though it cannot be overcome by the use of any lung-test, may be materially lessened by some very obvious considerations.

It is now generally admitted that the lungs of an infant may be inflated through the mouth, without having recourse to any instrument. All that is necessary is to secure the nostrils, to force the

larynx back upon the œsophagus, and to imitate the movements of respiration by the alternate compression and non-compression of the chest. Four instances of such successful inflation are referred to at p. 92 of this work. Schmitt succeeded in more than one instance * in completely inflating the lungs in this way: in two cases so perfectly, "that not even a single point was to be found in either lung into which the air had not penetrated." † Such a complete inflation of the lungs is not readily effected even out of the body; for I have repeatedly removed the lungs, and inflated them by the blowpipe, and in no case have I been able to expand the entire texture of the lung without rupturing some of the superficial air-cells, and producing emphysema. There is reason, therefore, to believe that it is not easy, even for an instructed and skilful person, to effect a complete expansion of the lungs by inflation; and it may be safely affirmed that such complete inflation could not be practised by an unskilful person. If, then, it were urged on a trial for infanticide, that the mother had resorted to inflation with a view of preserving the life of her child (for the supposition that it might be put in practice by a malicious person with a view of criminating the mother is too absurd to be seriously entertained), and it appeared in evidence that the lungs were completely expanded with air, the objection must fall to the ground. But even if the lungs were found very imperfectly distended with air, it would admit of grave doubt whether even this slight degree of distension could be effected by an uninstructed and unpractised female recently delivered of a child.

This is a case, too, in which circumstantial evidence would come to our aid; for to render the plea of inflation by the mother at all feasible, she must have shown in other ways her anxiety to preserve the life of her offspring. She must have made some preparations for her delivery, and must have prepared clothes for her child. In by far the majority of cases of alleged infanticide, no such preparations have been made; and when they have been omitted, it is not likely that the plea of inflation would make any impression on the jury. It would be still less effectual in that large class of cases in which there is not merely no evidence of due preparation, but the body of the child bears marks of violence.

Authors have laid down more than one distinction between the effects of inflation and respiration. Metzger, indeed, gives no less than four diagnostic marks. He states that inflation is distinguished by incomplete distension of the lungs, by flatness of the chest, by the want of crepitation when incisions are made into the lungs, but chiefly by the bloodless condition of the lungs, such bloodless condition not being accounted for by previous hæmorrhage. All these distinctions are unfounded; respiration also produces incomplete distension of the lungs, accompanied by perfect flatness of the chest, absence of crepita-

* Op. cit. Experiments, lxxx. and xcviii., also x. xliii. and xlix.
† Page 189.

tion, and a comparatively bloodless state of the lungs. The static lung-tests have also been employed as a means of diagnosis, on the well-founded assumption that inflation does not affect the weight of the lungs. Now as the static lung-tests do not serve to distinguish respiration from non-respiration, and the inflated lungs are, as far as the blood they contain is concerned, in the condition of lungs which have not breathed, it follows that the static lung-tests cannot distinguish respiration from inflation.

There is fortunately one available distinction on which but little stress has been laid. In all unskilful attempts to inflate the lungs of a child through the mouth, air is introduced in considerable quantity into the stomach. The absence of air, therefore, from the stomach would go far to prove that inflation had not been practised.

Assuming that, by a careful inspection of the lungs, we have convinced ourselves that either respiration has taken place or inflation been practised; and further, that the body of the infant has marks of violence upon it, that the stomach does not contain air, and that the circumstantial evidence, strengthened by the general considerations respecting the difficulty of inflating the lungs, convince us that the alternative of inflation is untenable; but that the infant must have breathed, a further inquiry is still needed before we can determine the question of live-birth, in the sense which the law attaches to that term. The question still to be answered is:—Did respiration occur before, during, or after birth?

Respiration may take place before complete delivery, *a.* in the passages; *b.* in the womb; and *c.* after the delivery of the head of the child, the body still remaining in the passages.

a. Respiration may take place in the womb in cases of face-presentation. Such an event, however, must be extremely rare, for face presentations occur once only in 280 deliveries, (1 in 279¾, Churchill). In this position, too, respiration would probably be extremely imperfect, so that the complete expansion of the lungs would at once negative the supposition of the child having breathed within the womb, and perished before complete delivery.

b. Respiration may also occur during the passage of the child through the vagina; and it is of frequent occurrence during the introduction of the hand to facilitate tedious labour, or to effect a change in the position of the child. It must also be admitted to be possible in cases where no manual assistance is given, provided the parts of the mother are capacious. In this class of cases, too, it is probable that respiration would be very imperfectly established, so that the complete distension of the lungs would negative the supposition of respiration having occurred only in the vagina.

c. Respiration after the delivery of the head of the child, and before the complete separation of the body from the parts of the mother, is a common event. In such a case no serious impediment is likely to be offered to the complete delivery of the child. Schmitt relates no less

than nine cases of this kind which occurred in his own practice, and in all of them the child was safely delivered. On the other hand, a few cases are recorded in which children, having breathed in this situation, perished before the completion of the labour; and the same fatal result may happen to children who have breathed in the womb or in the passages.

The possibility of respiration taking place before the complete separation of the child from the mother is thus placed beyond a doubt; and it must be evident that the mere inspection of the lungs will not enable the medical man to assert positively that respiration took place before, during, or after the birth. If respiration has taken place to a very limited extent, it may have occurred before birth; but if the lungs are found fully distended with air we should be justified in assuming that the child was born alive.

The examination of the lungs, with a view to ascertain whether respiration has or has not taken place, is not the only means we possess of solving the question of live-birth. We may succeed in obtaining better evidence than the state of the lungs can afford that a child has been born alive, by a careful examination of other parts of the body:—of the stomach, intestines, and bladder; and of the organs of circulation, the umbilical cord, and the skin.

The changes in the organs of circulation, in the umbilical cord, and in the skin, at the same time that they are proofs of live-birth, are also means of determining how long a child has survived its birth. The more minute examination of these points will, therefore, be reserved till the indications to be derived from the state of the internal viscera have been considered.

The *stomach* may contain milk, or farinaceous food, proving that the child was born alive, and had survived its birth long enough to have been fed. Milk is readily identified by its physical characters, and by Trommer's test, as used for detecting the presence of sugar in urine.* The farinaceous food may be identified by means of the starch it contains, which strikes with iodine-water a characteristic blue colour; and by means of the sugar which it contains, if it have been sweetened, the sugar yielding characteristic results when treated by Trommer's test. The presence of blood in the stomach also affords a probability of live-birth, for it is more likely to have been swallowed than to have been poured out as the result of disease.

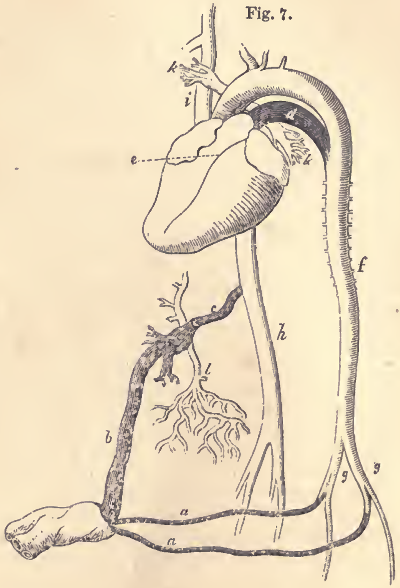
The examination of the *intestines* may sometimes throw light on the question under consideration. In mature still-born children, the large intestines are found filled with meconium; and although this may be

* Trommer's test. Add to the liquid to be examined a few drops of a weak solution of sulphate of copper, and an excess of caustic potass, and apply the heat of a spirit-lamp. The liquid assumes a deep violet tint, and on being heated lets fall a deposit of the red sub-oxide of copper. This test gives characteristic results with the whey and curd of milk, as well as with liquids containing sugar.

partially expelled during labour, a considerable quantity of it will remain in the large intestines in all cases of still-birth. The complete expulsion of the meconium, therefore, will furnish a strong probability that a child has survived its birth. But, on the other hand, the presence of a considerable quantity of meconium in the intestines must not be taken to prove that the child was not born alive, as its expulsion is sometimes delayed for some hours or days.

Some stress has been laid on the state of the bladder as a sign of live-birth. As this viscus is commonly emptied of its contents soon after birth, its being found empty has been regarded as a proof that the child was born alive. This sign is not to be depended upon, as there is no doubt that the bladder may be emptied of its contents during labour.

Fig. 7.



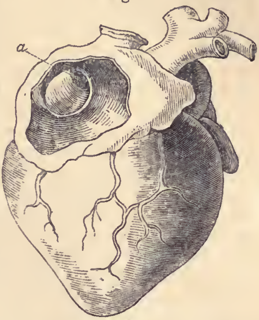
3. HOW LONG DID THE CHILD SURVIVE ITS BIRTH?

Our means of answering this question are less precise than could be desired. The extent to which respiration has taken place cannot be depended upon for this purpose; and recent observations have tended

greatly to impair the value of at least one of the three signs just referred to, namely—*a*. The changes in the organs of circulation; *b*. The state of the umbilical cord; and *c*. The state of the skin.

a. Changes in the Organs of Circulation.—There exist in the fœtus certain temporary additions to those organs of circulation which are destined for extra-uterine life. These additions consist of the umbilical arteries (*a a*), which return the blood of the fœtus to the mother; the umbilical vein (*b*), which conveys the blood of the mother, through the intervention of the placenta, to the fœtus; the ductus venosus, (*c*), which conveys part of the mother's blood direct to (*h*), the ascending cava; the ductus arteriosus, (*d*), which conveys the blood destined after birth to circulate through the pulmonary arteries (*kk*), direct into (*f*) the descending aorta; and the foramen ovale (*a* Fig. 8), situated at (*e*), which, by establishing a communication between the right and left auricle, makes the double heart of the future breathing animal, a single one during the life in the womb. All these parts, being unnecessary to extra-uterine life, are closed after birth.*

Fig. 8.



The Umbilical Arteries and Vein.—The obliteration of the *arteries* takes place much more speedily than that of the vein. At the end of the first twenty-four hours they present a marked diminution in their calibre, and an increase in the thickness of their coats near the umbilicus. At the end of two days the contraction extends through a great part of their length, and at the end of the third day reaches nearly to their termination in the iliacs. The changes which occur in the *umbilical vein* and in the *ductus venosus* take place much more slowly. During the first three days a slight contraction only takes place; on the fourth day this contraction is more marked, and on the fifth it is, with few exceptions, complete.

The changes that take place in the *ductus arteriosus* have been minutely described by Bernt of Vienna, and constitute the Vienna test. This vessel is about an inch in length, uniformly cylindrical, and about the size of the pulmonary artery. After a few respirations the vessel contracts towards the aorta; but after some hours or days, it resumes its cylindrical shape by becoming uniformly contracted throughout. At the end of a week it has diminished from the size of a goose-quill to that of a crow-quill. On the eighth day the duct is obliterated in half the children, and about the ninth or tenth in all of them.

* In the diagram referred to in the text, *g g* represent the iliac arteries, *i* the descending cava, and *l* the vessels of the portal system, derived from the umbilical vein.

The period of obliteration of the *foramen ovale* is extremely variable. Thus Billard found the foramen ovale obliterated in 1 out of 18 infants of a day old; in 4 out of 22 children of two days old; in 3 out of 22 children of three days old; and 2 in 27 of four days old. Devergie confirms these observations as to the uncertain period at which the foramen ovale is closed. No precise period can, indeed, be fixed for the obliteration of this aperture; it often continues open even in the adult, and, in some cases, without producing any dangerous consequences.

Bernt enters into some minute details respecting the situation of the opening of the fossa ovalis at different intervals after birth; but these details have no practical value. Indeed, the confidence formerly placed in the closure of the several fœtal vessels and of the foramen ovale, as signs of live-birth, and in the order and progress of the process of obliteration in those parts respectively, as means of determining, with some approach to accuracy, how long a child had survived its birth, has been lately rudely shaken; for it has been shown that, on the one hand, all the vessels and the foramen ovale may remain open in children who have survived their birth several days; and, on the other hand, that the two parts on the obliteration of which the greatest reliance has been placed (the ductus arteriosus and the foramen ovale) may be closed within a few minutes after birth, or even, in rare instances, previous to the birth.

Of the patency of the fœtal vessels after live-birth a good example is given by Mr. Henry Lee, in his 'Pathological and Surgical Observations,' p. 116. The umbilical vein, the ductus venosus, the ductus arteriosus, and the left umbilical artery, were all open; the right umbilical artery being closed only near the umbilicus, and yet the child from which the preparation was taken died from umbilical hæmorrhage when a fortnight old, and six days after the separation of the funis. Similar cases have been reported by Jörg and others. That the foramen ovale may remain open at very advanced periods of life is a fact too generally admitted to require proof. On the other hand, the little importance to be attached to the closure of the fœtal vessels and foramen ovale is shown by a case reported by Dr. Norman Chevers, and illustrated by a preparation exhibited at the Pathological Society, January, 1847. The child had survived its birth only fifteen minutes, and yet the ductus arteriosus was found uniformly contracted and so nearly closed as only to admit the shank of a large pin, while its coats exceeded in thickness those of any other of the large vessels. Dr. Chevers was of opinion that in this case the contraction of the vessel took place before birth; but it is scarcely necessary to resort to this supposition, though the anomalies occasionally met with, and among others the absence of the duct, certainly give some countenance to this opinion. Of the very early closure of the foramen ovale, a remarkable case was reported by Mr. Smith, at a later meeting of the Pathological Society (December 7, 1847). The child lived sixteen hours and died comatose. Upon examining the body,

the foramen ovale was found closed by a strong reticulated membrane firmly attached to its distinct annulus, impervious, and pouched. Dr. Chevers was inclined to the opinion that in this case, also, the closure had taken place before birth.

It appears, then, that the fact of the fœtal vessels and foramen ovale being open is no proof that the child was still-born; and, on the other hand, that the contraction of the ductus arteriosus and closure of the foramen ovale are quite consistent with a very short period of survivorship. The medico-legal value, therefore, of these tests of live-birth and survivorship is nearly on a par with the static lung-tests. The open state of the vessels will furnish merely a probability of still-birth, and the contraction or closure of one or more of the vessels merely a probability of live-birth. The length of time that the child has survived its birth could certainly not be safely inferred from an examination of the fœtal vessels.

b. Changes in the Umbilical Cord.—In a new-born child the umbilical cord is fresh, firm, round, and of a bluish colour; its vessels still contain blood, and its size varies according to the quantity of gelatinous fluid which it contains. The shrinking or withering of the cord is the first change that takes place: it commences at the ligature, and gradually extends to the umbilicus. In some cases it begins directly after birth; in others, not till some hours have elapsed; it is rarely delayed longer than thirty hours or two days, and never longer than three. The cord is now flabby, and sometimes a distinct redness is perceptible around the umbilical ring. The second change which takes place is the *desiccation* of the cord. It first assumes a reddish-brown colour, and becomes semi-transparent; it is then flattened and shrivelled; and when the process is still more advanced it becomes quite transparent, and of the colour of parchment. The umbilical vessels are distinctly seen contracted, and containing clotted blood, and are sometimes completely obliterated. The commencement of this process of desiccation dates from one or two to four days after birth. The period at which the process is complete varies from one to five days, but the most usual period is three days. The next stage of the process is the falling off of the cord; this usually happens on the fifth day. *Cicatrization* of the umbilicus is the last change which occurs, and this takes place about the tenth to the twelfth day. This description is based on the observations of Billard.

The changes which take place in the cord of a child born dead, are merely the common consequences of putrefaction. The phenomena of desiccation do not show themselves in the cord of a dead child till after the latest period at which desiccation takes place in the cord of a living child; and the cord of a dead child does not separate, though the cuticle can be readily peeled off.

c. Change in the Skin.—This consists in an exfoliation of the epidermis, beginning on the abdomen, and extending successively to the chest, groins, axillæ, interscapular space and limbs, and, lastly, to the

hands and feet. Sometimes the skin comes off in layers or scales, and sometimes in the form of a dust. This process of exfoliation, or desquamation, of the cuticle, sometimes begins when the child is a day old, sometimes it is delayed till the third or fourth day. It lasts, also, a variable period,—sometimes of thirty days, and sometimes of two months. It continues longest in feeble and delicate children.

This, too, is a vital process differing essentially from that separation of the cuticle which takes place in consequence of putrefaction. Although the period of its occurrence is variable, its existence will afford clear proof that the child has survived its birth.*

The following table, based upon the observations of Billard, present, at one view, the principal changes just described, with the probable date of their occurrence, and the proportion of cases in which the foramen ovale and ductus arteriosus have been observed to remain open.

Table combining the Changes which take place in the Umbilical Cord, with the date of the Obliteration of the several Openings.

Days.	Umbilical Cord.	Foramen Ovale.	Ductus Arteriosus.	Umbilical Arteries.	Umbilical Vein.	Ductus Venosus.
		Open per cent.	Open per cent.			
1	Withering.	74	68	Open.	Open.	Open.
2	. .	68	59	Obliteration advanced.	Open.	Open.
3	Desiccating.	64	68	Obliterated.	Open.	Open.
4	Beginning to separate.	63	63	. .	Contracted.	Contracted.
5	Separation usually complete.	45	52	. .	Obliterated.	Obliterated.
8	Separation complete.	25	15			
10 to	Cicatrization commencing.					
12	Cicatrization complete.					
	Mucous Exudation.					

Assuming the two questions—1. Was the child born alive? and, 2. If born alive, how long has it survived its birth? to have been answered in the affirmative, we may have next to inquire,

* Billard, 'Maladies des Enfans,' pp. 13-24.

HOW LONG HAS THE CHILD BEEN DEAD?

The process of putrefaction differs in no material respect in the adult and in the infant. The same changes occur in the same order. The animal heat is first extinguished, rigidity then comes on, and putrefaction follows. The body of the new-born infant parts with its heat very quickly; the rigidity is as great, and lasts as long in the infant as in the adult; and putrefaction, according to Devergie, goes on more rapidly. These facts must be borne in mind when we are deciding the question before us. With the exception of the time required, the principles that will guide us in our decision will be the same at all ages. These will be the subject of a future chapter. The effects of intra-uterine maceration, described at p. 77, must not be confounded with those of putrefaction. The absence of the putrefactive odour will supply a sufficient diagnostic mark.

WHAT WAS THE CAUSE OF DEATH?

There are several ways in which the life of a child which has been born alive may be sacrificed, within a short period of its birth, without any violence being used on the part of the mother. *a.* It may be so immature or so feeble as to be unable to maintain an independent existence; *b.* it may encounter accidental obstacles to the continuance of the respiration; or, *c.* it may labour under a congenital disease which will effectually prevent the establishment or continuance of the several vital functions.

a. The death of an infant after a few respirations, in spite of the most skilful and persevering attempts to restore animation, is an event too well known to every accoucheur to require proof or illustration in this place; and such an event must be of more common occurrence in the case of children born under circumstances which preclude any effectual assistance. Among the more common causes of the early death of the infant may be mentioned a long and tedious labour, hæmorrhage, and continued interruption to the circulation through the cord; to which may be added the immaturity or feebleness of the infant itself. It ought also to be understood that the same causes which occasion still-birth promote the early death of children born alive. Thus large children more frequently perish in the birth, or die soon afterwards, than small ones, and male children (as being larger) more frequently than female children. Again, the danger to the child is greater in a first pregnancy than in subsequent ones. It is probable, too, that in the absence of violence, or even of intentional neglect on the part of the mother, many more illegitimate children would be still-born or die soon after birth than legitimate children. The reports of obstetric practitioners have shown that, while the mortality of legitimate children is about 1 in 20, that of the illegitimate is

about 1 in 10; while the deaths of males are to those of females as about 7 to 5.

b. Among the accidental obstacles to the continuance of respiration may be mentioned, such a position of the infant as shall cause the mouth to be applied to some soft and yielding object, or to be immersed in blood, in the discharges, or in water; and the accumulation of mucus in the mouth, nostrils, and air-passages. It may also be added that there are cases in which respiration is altogether prevented, as when the child is born in the membranes.

c. The congenital diseases which may prevent the establishment of the several vital processes, or render their continuance for any length of time impossible, have their seat in the three organs most essential to life;—the heart, the lungs, and the brain.

Diseases of the heart and large vessels.—These diseases are rare in infancy; but malformations accompanied by contraction or early closure of the fœtal vessels have an important medico-legal bearing, as affording a presumption in favour of death from natural causes.

The diseases of the *lungs* are more important in relation to the present question. They are six in number,—1. Hepatization (red and grey), the consequence of pneumonia occurring before birth. 2. Pulmonary apoplexy. 3. Pulmonary tubercles. 4. Œdema. 5. A disease described by Devergie, under the name of œdema lardaciforme, which seems to be quite as nearly allied to schirrus as to œdema. It affects the thymus as well as the lungs. And, 6. A condition of lung known as atelectasis pulmonum.

These diseases of the lungs may affect either their entire structure or a part only. Where the whole lung is involved, it is clear that respiration cannot be perfectly established, and the child cannot long survive its birth; where, however, the disease is partial, the medical man must state, to the best of his judgment, whether it is extensive enough to prevent the continuance of life.

The condition of the lungs to which Dr. Jörg of Leipsig has given the name of *atelectasis pulmonum*, or imperfect expansion of the lungs, is not, strictly speaking, a disease, but merely an absence of respiration and a persistence of the fœtal condition, which is found in by far the majority of new-born children, and may even continue for days or weeks. The substance of the lungs in the unexpanded parts is perfectly healthy, the want of expansion depending probably upon some defect of innervation.

The chief diseases which affect the *brain and spinal marrow* are apoplexy, and accumulations of fluid and morbid softening. The apoplexy of the fœtus and new-born infant differ in no respect from the apoplexy of the adult. M. Lasserre (Ranking's 'Retrospect,' vol. iii. p. 342) gives a case of meningeal apoplexy, a second of effusion of blood into the ventricles, and a third into the posterior part of the left hemisphere. When serum exists to a limited extent either between the membranes or in the ventricles of the brain, life is

not necessarily compromised, at least not within a short period of birth; when, however, the accumulation of serum is considerable, it may materially interfere with the functions of life, and would afford a sufficient explanation of the premature death of the child. The same remark applies to morbid softening of the brain and spinal cord. It must be borne in mind, however, that the brain of the fœtus is naturally softer and much more vascular than that of the adult.

The same remark applies to all the diseases just specified, viz. that they are not of frequent occurrence; and that when they are present, it is rarely to such a degree as to account for the speedy death of the child, or to have any important bearing on the question of infanticide.

It is only when proofs of respiration are present that these signs of death from natural causes have any value; and in the case of children who have survived their birth but a short time, it may be laid down as a general rule, that the absence of marks of violence affords a fair presumption that death has been due to natural causes. It is true that, in such a case, the child may have been the victim of intentional neglect, and may have died from the want of those simple aids by which the lives of children in more favourable circumstances are preserved; or it may have been prevented from continuing to breathe by simply closing the mouth and nostrils; but the medical man has no means of detecting these causes of death, and the accused must have the benefit of the doubt which attaches to the case.

Was the Death due to Violence.—In answering this question we shall have to consider whether the injury which the child has sustained might have been the result of accident.

In some cases the traces of injury are so marked and of so undoubted a character, that we may decide without hesitation that they are due to murderous violence. Punctured wounds of the fontanelles, orbits, heart, or spinal marrow, dislocation of the neck, separation of the head from the body, extensive fracture of the bones of the head and face, suffocation by plugging the fauces, or strangulation effected with unusual force, tell their own tale.

But there are cases in which the nature and cause of the injury are only to be determined by reference to obstetric experience and medico-legal experiments, illustrating the mechanical injuries which the child may sustain during and immediately after the birth.

Suffocation.—Respiration, as has been already stated, is sometimes prevented or arrested by purely accidental causes which leave no mark of injury on the child; so that the medical witness has no means of stating whether the child fell into the position of danger, or was intentionally placed in it, or was allowed to remain in it when it might have been rescued from it. This difficulty presents itself in a case of not uncommon occurrence. A child is found in a privy, and the question arises whether it was suffocated by being thrown into it, or expelled while the mother was there for a natural purpose. In such a case, if respiration is found to have taken place extensively or

completely there would be a strong presumption against accident. On the other hand, very imperfect respiration would afford an equally strong probability the other way, provided it can be shown that such sudden and unexpected deliveries do take place.

Many cases of sudden parturition in such situations are on record, Thus, Jörg relates the case of a pregnant woman who "on account of a desire to evacuate the bowels, went to the night-stool, and brought forth sitting on this, without any pain or bearing down, a large boy, who first struck the edge of the night-stool with his head, and then fell on the ground."* There was in this case an extravasation of blood on the left parietal bone. Mr. Tatham also mentions the case of a married lady delivered of twins on the night-stool. It was not her first labour, but probably her second. Both the children died.†

Such cases of sudden parturition, though not of very uncommon occurrence, are rare in women who have not previously borne children. It must be admitted, then, as *possible*, that a fœtus found dead in a privy may have been discharged in the course of a sudden delivery, and have died suffocated. Sometimes the child so expelled falls into water instead of into night-soil. In this case, and generally where the body of an infant is found in water, a question will arise whether the child died by drowning, or was placed in the water to conceal some other mode of death.

Suffocation by the introduction of foreign substances, such as mud, straw, feathers, wool, and wet linen into the mouth is not an uncommon cause of death. In such cases the question arises whether the foreign substance could have been drawn into the mouth by the act of inspiration, or whether it must have been forcibly and intentionally introduced. No general rules can be laid down for the decision of this question. When a plug of wet linen or other similar material is employed, the mucous membrane is stated to be congested anterior to the situation of the plug, and pale where the greatest pressure has been exerted.

Another mode of effecting suffocation is by rolling the tongue back into the throat. As the tongue would probably resume its original situation, it is not likely that this cause of death would be detected.

Strangulation.—A child may be strangled by the application of a cord, and yet no marks of violence appear on the neck. But even where marks of violence do show themselves by a discoloured depression round the neck;—is it certain that this has been done by the mother? Might not this appearance arise from the twisting of the cord around the neck, or by the pressure of the neck of the womb? Klein, an eminent German authority, has examined this point with great care. He says: "I have never met with an instance of marks of injury of the kind supposed—ecchymoses or suggillations—produced

* 'Die Geburtshülfliche Exploration,' p. 116.

† 'London Medical Repository,' vol. i. part iv. New Series.

by the orifice of the uterus, or by the umbilical cord, although I have known a great number of cases in which the neck of the infant had been strongly girded by the funis once or twice twisted round it, strangulation having been either actually produced, or rendered most palpably imminent." He then goes on to speak quite as decidedly regarding the pressure of the neck of the uterus; not a bruise, as he tells us, nor mark of any kind being left on the infant which has perished in this way. A case mentioned by Jörg shows that the experience of Klein is not to be implicitly trusted:—"The navel string had been twisted five times round the neck, and had left five tolerably deep red impressions." Taufflieb also has reported cases of the same kind,* and there are several English cases on record to the same effect.

The presumption in favour of strangulation by the umbilical cord admits of being rebutted in those cases in which the cord is unusually short. It may be stated in this place that the length of the cord is subject to great variety. Though its most common length is 18 inches, it may be as short as 4½ inches and as long as 69 inches. (Churchill's 'Midwifery,' 3rd edition, p. 108.)

Marks of pressure on the neck, therefore, cannot always be attributed to intentional violence; but as, in most instances, a murderer uses more force than is necessary, it will often happen, in cases of infanticide, that the marks are too distinct to be accounted for by the accidental twisting of the umbilical cord round the neck. Moreover, if respiration is found to have been completely established, there will be the strongest presumption against the strangulation having been produced by a cause acting during the birth. On the other hand, the absence from the lungs of all signs of respiration will afford a presumption in favour of the constriction having been due to the umbilical cord.

Strangulation may also be effected by the pressure of the fingers on the throat, in which case ecchymoses may be found corresponding with the cause.

Drowning.—The signs of this form of death are the same in the infant and in the adult. These signs will be described in a future chapter.

Fracture of the Skull.—This may happen in three ways:—1. In the course of labour. 2. By falls on the floor. 3. By intentional violence.

1. The possibility of fracture of the bones of the skull being produced during labour, is proved by more than one well-authenticated fact. Siebold relates a case in which a female with a very narrow pelvis was delivered, by the efforts of nature alone, of a well-formed still-born female child. On examining the head, a great quantity of blood was found extravasated upon the surface of the cranium, and there were three fissures in the left parietal bone, and one in the left

* 'Annales d'Hygiène,' vol. xiv. p. 340.

frontal bone. Michaelis of Keil also reports the case of a woman with a well-formed pelvis, who was delivered of her first child after a natural labour. The child breathed both during and immediately after birth, but then died. The head was much disfigured; and on examination, the right parietal bone, which during birth had been directed under the promontory of the sacrum, was covered anteriorly and above with effused blood, and on the removal of the periosteum was found fractured in five places. The whole of this bone was uncommonly thin. On opening the skull there was found no extravasation beneath the fissures, but the longitudinal sinus was ruptured, and there was an extensive coagulum on the cerebrum on both sides, under the dura mater, and on the tentorium.* These two cases will show the great amount of injury which the head may sustain during birth.

Seeing, then, that fracture of the skull during labour is possible, what is the difference between fractures thus produced, and those the result of intentional violence? There is no essential difference between the two forms of injury, except in those cases in which unusual violence has been used, the fracture being minutely comminuted and accompanied by depression; or the fracture not being limited, as it commonly is when caused by pressure of the womb, to the parietal and frontal bones, but extending to other bones of the skull, and even to the bones of the face.

2. On the subject of fractures of the skull caused by falls on the floor, Chaussier has made some interesting experiments. Fifteen still-born children were allowed to fall perpendicularly, and head foremost, from a height of 18 inches on a stone floor. In 12 of them one or other of the parietal bones was broken. When the height was 3 feet and upwards the fractures were proportionably greater. Fractures were also produced by strong pressure and by blows.†

But Dr. Klein has adduced facts which seem to render it doubtful whether fracture ever occurs in sudden labours from falls on the floor. He availed himself of the opportunities he possessed, by his official station in the kingdom of Würtemberg, to procure returns of all such labours occurring within his jurisdiction. The result was 183 well-authenticated cases, in 150 of which the mothers were suddenly delivered standing; yet there was not a single case of death among them, nor of fracture of the skull, or other mischief happening to the infant; though some of the children had fallen on bare boards, and some on the pavement. The reason of the difference between the experiments and those cases occurring naturally is supposed to be that, in the latter, the direction in which the body of the infant is projected is oblique, and the fall is not so instantaneous as in the experimental essay.

The truth would appear to lie between these experiments of

* These cases are quoted by Beck, Art. Infanticide.

† 'Considérations Médico-légales sur l'Infanticide,' par Lecieux.

Chaussier and the facts collected by Klein; for Dr. Cohen von Baren has succeeded in bringing together several instances of fracture of the skull from falls in cases of sudden delivery. Out of 50 cases reported by him, 30 children were born while the mother was standing, 17 while stooping or sitting, and 3 while kneeling. Of the 50, 32 were first-born, and 42 were at full term. Of the 19 infants born while the mother was standing, one only had fracture of the skull, and the cause of this was doubtful. But it appears that out of 25 cases in which the cord was ruptured, 5 presented fractures of the skull. These fractures of the skull occasioned by falls can also be distinguished from those due to intentional violence only by the comparatively slight injuries sustained in the one case contrasted with the extensive injury commonly inflicted in the other.

In cases of fracture of the skull due to a fall during sudden delivery, the umbilical cord is liable to be torn through, especially if it does not exceed, or falls short of, the usual length. The seat of the rupture is usually within one or two inches of the navel. If the umbilical cord, instead of being torn, should be found divided by a cutting instrument, it might be inferred that the injuries to the head were due to accident. In any case, the state of the cord ought to be ascertained.

Fracture and Dislocation of the Neck.—These injuries are never present before birth; and as they are not caused by falls on the floor, they may be taken as sure signs of criminal violence.

Contusions.—In examining bruises on the head it is necessary to bear in mind, that tumours commonly result from compression of this part during labour: a mere swelling on the head must not, therefore, be taken for a mark of criminal violence.

Incised and Punctured Wounds.—There is nothing peculiar in these wounds as inflicted on the new-born infant. For the distinction between these and other wounds inflicted during life and after death, the reader is referred to the subject of Wounds.

Poisoning.—The rules for the examination of the stomach and intestines, and of the substances contained within them, are the same for the infant and the adult; they will therefore be treated of under the general head of Poisoning. This form of death is rare in the case of the new-born child; but several cases of poisoning by the mineral acids characterized by the same appearances on the body of the infant and on the clothes as mark the action of those acids on the adult, have lately occurred. In all these instances the crime was committed at a considerable interval after the birth of the child. In determining whether an infant has fallen a victim to poison, it should be borne in mind that the alimentary canal, in common with other important organs of the economy, is subject to disease. Sometimes the lining membrane of the *œsophagus* presents a marked injection, in the form of spots, longitudinal lines, or ramifications. These may happen to be arranged transversely and may be mistaken for the effects of a ligature applied to the neck. *The stomach*, moreover, may be the seat of

ulcerations with a sanguinolent, dark-coloured discharge; and the same changes may be found in the rest of the alimentary canal.

Infanticide by Omission.—The omission to tie the umbilical cord sometimes proves fatal; and there can be no doubt that that omission is in some instances a criminal one. Some authors have doubted the correctness of the general opinion of the necessity for tying the cord, and have adduced arguments in favour of their own view of the case. There are, however, facts enough on record to show that such an omission may be attended with danger. Foderé relates one case in which the child perished in consequence of the ligature becoming loose;* and Dr. Campbell two fatal cases, one from the accidental, the other from the intentional, removal of the cord.†

It is probable that fatal hæmorrhage would very rarely follow a rupture of the cord, and this probability is strengthened by the testimony of Klein. Such a rupture of the cord is not necessarily the act of the mother, for it may occur in cases of sudden delivery taking place in the erect posture.

The signs of death from hæmorrhage are the paleness of every part of the body, and the small quantity of blood contained in the heart and large vessels. In the absence of wounds to account for the hæmorrhage, such a bloodless state of the body may be regarded as in all probability the effect of hæmorrhage from the cord.

The child may perish by other acts of omission. The mother may have failed to provide proper clothing or food, to remove it from a position of danger, to clear the mouth of mucus, or other accidental impediments to breathing. Supposing it to have been previously shown that the child had survived its birth for some days, death from want of food would betray itself by the great emaciation of the whole frame, and the empty state of the alimentary canal. In these cases the child is at the same time often exposed to the action of cold, which form of death is characterized by pallor of the surface, with congestion of the internal parts.

Such cases of infanticide by omission being difficult of proof are never punished with death, but the mother is convicted of the lesser crime of concealing the birth; and even when marks of violence are found on the body, the inquiry generally assumes so complicated a shape, that the jury cannot be induced to return a verdict of wilful murder.

EXAMINATION OF THE MOTHER.

The first inquiry with reference to the female suspected of having given birth to the child is,—Whether she has been recently delivered, and if so, whether the period of her delivery corresponds with the

* Vol. iv. p. 515.
† 'Introduction to the Study and Practice of Midwifery,' p. 151.

time at which the child is supposed to have been born. This part of the inquiry belongs to the subject of delivery (p. 59).

Another inquiry may be necessary in certain cases; and that is into the state of the mother's mind. Puerperal insanity is by no means a rare disease, and there is no doubt that it sometimes takes the form of homicidal mania, threatening the life of the child. An interesting case of this kind is quoted by Paris and Fonblanque.* It was that of a married woman, of good reputation, who being delivered of a child, and not having slept many nights, fell into a temporary frenzy, and whilst alone killed her infant; but company coming in, she told them that she had killed it, and *there* it lay. The good reputation which the woman had previously borne, the long want of sleep, and the entire absence of the usual motives to the commission of such a crime, added to "many circumstances of insanity appearing," led to her acquittal. Dr. Paris observes, in reference to this case, that "had this woman been of doubtful character, though innocent, she might have been executed for want of medical evidence to prove the nature and frequency of puerperal insanity."

A question of some importance in its bearing on infanticide, and having reference to the mother, relates to the strength which a female recently delivered possesses. There is no doubt, that, as a general rule, a woman recently delivered possesses the strength requisite for the destruction of her child's life. Thus, Foderé relates the case of a French widow, who being seized with labour pains while receiving a visit from eight of her neighbours, complained of colic, and seating herself on a bucket in bed, as soon as the child's head passed the vagina, squeezed it flat by compressing it with her thighs. That a woman has strength enough to move about and exert herself after her delivery, is proved by the successful concealment of the fact of delivery and of the dead infant in the large majority of cases brought to trial, as well as by well-authenticated instances of females walking several miles, or resuming laborious occupations on the very day of their delivery.

This subject of infanticide will be best brought to a conclusion by the following summary of the chief points to be attended to in cases of infanticide.

1. Examine the body of the child in order to determine its degree of maturity; for this purpose, weigh and measure it, ascertain the position of the centre of the body, and attend to the several points comprised in the description of the growth and development of the fœtus (p. 63). Note also any malformation which may be present.

2. Note the several circumstances by which the time that has elapsed since the death of the child may be determined, such as the presence or absence of animal heat and rigidity, the existence or non-existence of putrefaction, and, if putrefaction be present, the degree to which it has advanced.

* 'Medical Jurisprudence,' vol. iii. p. 129.

3. Examine the entire surface of the body with a view to ascertain the presence of marks of violence, and, if any be present, determine whether they might have been produced during birth, or by accidental causes acting after birth. Examine the mouth for foreign bodies introduced into it, and the fontanelles, orbits, heart, and nuchæ, in search of wounds inflicted by pointed instruments. Note the state of the umbilical cord, measure it, and ascertain whether it has been torn or cut; and observe the condition of the skin.

4. Open the chest, and remove the heart, lungs, and thymus gland. Separate the lungs, and carefully inspect their surface. Observe whether they are of a uniform liver-colour and compact consistence throughout, or uniformly spongy like the adult lung, or mottled with developed air-cells, as in imperfect respiration. If there are any parts of a lighter colour than the rest, observe whether the structure of the lung itself is developed in those parts, and distinguish the developed air-cells from air contained beneath the pleura, the result of incipient or advanced putrefaction, by applying gentle pressure with the finger. In lungs which are free from putrefaction, the hydrostatic test may be resorted to, to ascertain the degree of buoyancy of the lungs, as a measure of the quantity of air which they contain.

5. Examine the heart and blood-vessels; the foramen ovale, the ductus arteriosus, the ductus venosus, and the umbilical arteries and vein. Observe whether these several parts are contracted or obliterated, and to what extent and degree; and whether they contain much or little blood.

6. Examine the stomach to ascertain whether the child has been fed, using for this purpose the tests for sugar, milk, and starch; if there is any appearance of inflammation in the alimentary canal, test its contents with a view to the discovery of poison. Note whether the intestines contain meconium and in what quantity, and whether the urinary bladder contains urine.

7. Examine the bones of the skull both at the vertex and base, in search of fractures. Inspect the brain and its membranes, and note any effusion of blood or serum. Examine the spine and spinal cord with a view to the discovery of dislocation or fracture of the vertebræ.

8. Examine the suspected female in order to ascertain whether she has been recently delivered, and how long. It may be necessary, also, in certain cases, to inquire into the state of the woman's mind.

It is notorious that the law, as it now stands, is altogether inoperative, and that the only punishment really awarded to the child-murderer is the two years' imprisonment with which it visits the concealment of the birth. This impunity is due to the unnecessary refinement of the law, which requires at the hands of the medical man a distinction that, in most cases, it is out of his power to make. The child must be *born alive*, and unless the medical witness can prove that it has been born alive, it may bear on its body the

clearest marks of murderous violence, and yet the murderer may escape unpunished.

In most instances, the crime of infanticide is committed so soon after the birth of the child, that the only proof of its having been born alive is that furnished by the presence of the signs of respiration. But it has been already shown that respiration may take place before and during the birth, as well as after it; and, in by far the majority of cases, all that the medical man can succeed in proving is, that the child has or has not breathed. It is not in the nature of things possible that he should say whether respiration, if it have taken place, occurred before or after the birth. Now, it may be fairly asked, Why require proof of live-birth at all? for it is notorious that this question does not lead to the punishment, but to the escape, of guilty persons.

The suggestion which we would make is this: Let the law be so framed as to exclude as much as possible all appeal to scientific authority. If the child-murderer is to be punished, all question as to the child being *born alive* must be done away with; and whenever there are found on the body of an infant marks of violence sufficient to account for its death, which marks of violence could not be produced in the natural progress of the labour, or by any accident occurring afterwards, let the female be punished as guilty of murder. Medical evidence would thus be restricted to the question of the true cause of the injuries found on the child. There would be no injustice in such an enactment, for the same injuries which would destroy the life of a child that had already breathed, would effectually cut off all chance of the preservation of a child in whom the act of respiration had not yet taken place; and it is in the highest degree improbable that a female would inflict such injuries on a child that did not show some signs of life.

On the other hand, as, in the absence of all external injury, it is impossible to prove that a child has been murdered; and yet it may be easy to show that the female has been guilty of criminal negligence; let that criminal negligence be punished according to its degree. The law, as it now stands, contemplates only one degree of criminal negligence, viz., the concealment of the birth; and the concealment of the birth, except in as far as the life and well-being of the child are thereby affected, is but the concealment of shame. The concealment of the birth is criminal, inasmuch as such concealment presupposes the want of that assistance which all women know to be necessary to the well-being of the new-born child. Let the concealment of the birth, then, be punished as now, by imprisonment for such a time as the law sees fit. Another omission, —that of providing proper clothing and shelter for the child—at present escapes punishment altogether, and certainly demands a separate enactment.

LEGITIMACY.

The law always supposes that a child born in wedlock has the mother's husband for its father; but this presumption may be rebutted by evidence of non-access on the part of the husband, or impotence, or any other cause which makes it impossible that the reputed should be the real father.

There are several circumstances out of which the question of legitimacy may spring. A woman may bear a child after her husband has been absent from her more than nine calendar months; and in this case the question arises, Does the period of utero-gestation admit of being extended beyond this the *usitatum tempus pariendi?* On the other hand, a woman within an unusually short period of her marriage may bring forth a child capable of being reared, and here the question may arise, what is the earliest period at which a viable child may be born. Again, a woman before the expiration of the full term of nine calendar months from the date of her marriage, say in the 7th or 8th month, may be delivered of a child having the size and general appearance of one at full term; and it may become a question whether a child of such a size, and apparently so mature, could have been of the supposed age. Here an accurate knowledge of the growth and development of the fœtus will be necessary.

Lastly, a woman may give birth to a child during the life-time, or after the death, of her husband, he having been at the time of the conception of the child in such a state of feebleness or disease, or imperfect convalescence from some severe malady, as to give rise to the question whether he could have been the father of the child. A question of paternity may also arise, where there is no doubt of the legitimacy of the child, in consequence of the marriage of the mother to a second husband immediately after the death of the first. Some cases of disputed legitimacy turn on the alleged impotence of the husband. (See the Chapter on Impotence.) The questions which fall to be examined in this place are chiefly—1. The Duration of Pregnancy, and 2. The Viability of Children.

1. DURATION OF PREGNANCY.

This is a question to be decided by medical evidence; for, though the practice of our courts of law is to consider forty weeks as the more usual time, medical men are allowed to give evidence as to the possibility of that period being extended.

The general belief among medical men, as well as among the vulgar, is, that the period of utero-gestation in the human subject is 9 calendar months, 10 lunar months, 40 weeks, or 280 days; and we often meet with the less definite expression "9 months, or 40 weeks." Now, it is important to understand that there is a material difference between 9 calendar months on the one hand, and 10 lunar months, 40 weeks,

or 280 days, on the other; for nine calendar months may consist either of 273, 274, 275, or 276 days, falling short of 280 by from 4 to 7 days.

This want of precision in estimating the duration of pregnancy arises in part from the inadequacy of the means we possess of determining the duration of pregnancy in particular cases. These means are *four* in number.

1. *Peculiar Sensations* at or about the time of conception. 2. *Cessation of the Catamenia.* 3. *The Period of Quickening:* and 4. *A single Coitus.*

1. *Peculiar Sensations felt at, or soon after, Conception.*—This mode of reckoning is inaccurate, inasmuch as these sensations are not defined so as to be recognized by those who conceive for the first time; they are not constant in their occurrence in the same female; and they do not take place at any particular period.

2. *The Cessation of the Catamenia.*—There are also great objections to this mode of reckoning, for the catamenia may cease from causes other than conception. Hence the following case is a possible one: a woman, from some cause quite independent of conception, ceases to menstruate, and immediately before or after the next suppressed period she conceives, but she dates the conception from the first suppressed period. As the cases of protracted gestation are not very numerous, a part of them may perhaps be explained in this way. On the other hand, a female may menstruate once, or more than once, after conception, in which cases her reckoning will fall short of the real duration of pregnancy.

But, even allowing the cessation of the catamenia to be a sound starting-point, it can give only an approximative result; for as in most women 28 days (according to the best authorities) intervene between the commencement of one menstrual period and the commencement of another, there may be an interval between the termination of one menstrual period and the beginning of the next of nearly 28 days; say 25 days. If conception be assumed to take place on the first day after the cessation of the menstrual discharge, and we reckon from the first suppressed period, the calculated duration of pregnancy would fall short of the real duration by 25 days. If, on the other hand, we assume conception to take place on the day preceding the *suppression*, and we calculate from the last appearance of the menses, the calculated duration of pregnancy would exceed the real duration by the same period of 25 days.

To avoid this possible error of 25 days, accoucheurs have adopted the expedient of dividing the interval between the two periods into two parts, and reckoning from the division. In this way the possible error is reduced to twelve or thirteen days.

Our estimates would differ less widely from the truth in those cases in which the interval is greatly contracted, either by the menses continuing for several days or recurring more frequently than usual,

as every three weeks, or every fortnight: they would, on the other hand, be more remote from the truth in those instances in which the interval is prolonged to five or six weeks, or even two months.

3. *The Period of Quickening.*—The inadequacy of this event as a starting-point from which to reckon the duration of pregnancy will be inferred from what has been already stated in speaking of the signs of Pregnancy, viz. that quickening, where it is perceived, occurs at very variable periods, having a range, according to the best authorities, of six weeks (from the 12th to the 18th), and, if we combine the statements of several authors, of sixteen weeks, namely, from the 10th to the 26th week.

4. *A single Coitus.*—This is the only accurate mode of reckoning; and a sufficient number of well-attested facts of this class have now been collected to prove that the duration of pregnancy is subject to considerable variation, as well as to a marked excess above 280 days.

The following table embodies the results of 14 cases in which the duration of pregnancy was determined by a single coitus.

Average of the 14 cases	284 days.
Minimum	270 ,,
Maximum	293 ,,
Range	23 ,,
Excess above 280 days	13 ,,
Excess above 9 calendar months	17 to 20 ,,

The inferences to be drawn from cases in which the duration of pregnancy was fixed by a single coitus, admit of being strengthened by cases of an analogous kind, in which the sudden death of a husband, or the date of his separation from his wife, is used to determine not the exact duration of pregnancy, but its minimum duration, for in using this mode of reckoning it is commonly assumed that the pregnancy dated from the very day of death or departure.

The following table gives the results of 27 cases in which the exact duration of pregnancy, or the mininum duration, was determined either by a single coitus, or by the sudden death of the husband, or by his separation from his wife.*

Average of the 27 cases	284 days.
Minimum	260 ,,
Maximum	308 ,,
Range	48 ,,
Excess above 280 days	28 ,,
Excess above 9 calendar months	32 to 35 ,,

The results of these cases, then, furnish the strongest possible reason for regarding the period of utero-gestation as variable and not fixed,

* The author is indebted for the case of 308 days to Mr. Hewitt, a former pupil of King's College. The duration was ascertained by the sudden death of the husband. Cases of less than 260 days are excluded.

and as so great an amount of variation is shown to exist in so small a number of cases, we may fairly expect a still greater difference from the collection of a greater number of similar facts.

The inference drawn from these facts derives the strongest confirmation from the analogy of animals.

Formerly the period of gestation in animals, like that in the human species, was held to be a fixed period. For instance, the duration of pregnancy in the mare was fixed at 11 months, and in the cow at 9 calendar months. Subsequent observations have shown that, in those animals, the period is far from being a fixed one, and has thus furnished a strong argument to the advocates of a variable period in the human species.

The well-known observations of M. Tessier, which extended to 102 mares and 160 cows, give the following striking results:—

	In the Mare.	In the Cow.
Shortest period	311 days.	241 days.
Longest period	394 ,,	308 ,,
Range	83 ,,	67 ,,
Excess above the stated period	57 or 60 ,,	32 or 35 ,,
Average period . .	11 mths. 10 ,,	9 mths. 10 ,,

The difference observed in the case of both these animals is very remarkable, and certainly much greater than might have been anticipated. The excess above the assumed period is also very great in both instances.

Earl Spencer has made a still more extensive series of observations on the period of gestation in the cow.*

His lordship's observations were made on 764 cows, and the results may be briefly stated thus:—

Shortest period of gestation, a live calf being produced	220 days.
Shortest period of gestation, when the calf was reared	242 ,,
Longest period of gestation . . .	313 ,,
Range (greatest)	93 ,,
Range in the case of a viable calf . .	71 ,,
Excess beyond 260 days, before which period his lordship considers a calf decidedly immature	53 ,,
Excess above 9 calendar months .	37 or 40 ,,
Excess above 10 lunar months . .	33 ,,
Average duration . . .	284 or 285 ,,

It appears also to be well made out, from his lordship's observations, that by far the majority of instances of gestation protracted beyond

* See the 'British and Foreign Medical Review' for Jan. 1841.

the average period, occurred in the case of bull-calves, the numbers being, of cow-calves 90, of bull-calves, 152.

These observations of Lord Spencer, added to those of M. Tessier, establish beyond a doubt the fact, that the period of utero-gestation in the cow and horse, which, like that of the human subject, was formerly regarded as fixed, is not only variable, but that the extremes are widely separated from each other, and the longest period in excess by considerably more than a calendar month of the average duration.

The case in favour of a variable period in the human subject admits of being strengthened by other arguments.

All the functions of the human body which have been carefully examined, such as the pulse, the respiration, the secretion of urine, and the cutting of the teeth, are found not only to be variable, but to vary within wide limits. So also with those functions which have a close connection with pregnancy: for instance, the catamenia. They make their first appearance at any age, from 9 years up to 23 or 24 (and even earlier and later than those ages), and they continue up to any age from 35 to 55, or even later. In some women they recur at intervals of a month, in others of six weeks, in others of a fortnight, and each period may comprise a variable number of days. Then, again, the period of quickening varies from the 10th or 12th to the 18th or 20th week, or even later; and child-bearing, which in the majority of cases ceases at 45, may occur as late as 54, and possibly at a still more advanced age.

Another argument of no slight force in favour of a variable period, and of the possible extension of pregnancy beyond the usually assigned limit, is to be found in the fact that the advocates of a fixed period are by no means agreed among themselves as to what that fixed period is to be. Thus of the seventeen medical men examined in the Gardner Peerage case, five advocated a fixed period, and were opposed to the idea of protracted gestation, but all of them stated the duration of pregnancy differently, and, with the exception of Sir Charles Clarke, who fixed it at 40 weeks or 280 days, were forced to admit a greater or less deviation from an absolutely fixed period. Dr. Gooch, for instance, stated it at from a day or two before to a day or two after 9 calendar months, and Dr. Davis at a day or two under 9 calendar months; while Dr. Blegborough allowed an interval of from 39 to 40 weeks; and Mr. Pennington of from 37 to 40 weeks.

If the advocates of a fixed period, all of them men of acknowledged eminence and experience, could differ thus widely in their estimates, they might differ as widely from nature herself.

But while five of the seventeen medical men examined in the Gardner Peerage case thus supported the opinion that the period of gestation was fixed, or nearly so, twelve believed that it might be protracted to 9½, 10, or 11 calendar months, or (288—290) (304—306) (334—337) days.

The balance of authority, both ancient and modern, may be also adduced in support of the theory of a variable period and of possible extension of pregnancy beyond the usual period of about 280 days. Among modern authors of note may be cited the names of Hunter, Foderé, Gardien, Velpeau, Capuron, Desormeaux, Richerand, Dewees, Hamilton, Burns, Denman, and Montgomery.*

To the foregoing arguments may be added the fact, that legal decisions in this country have been favourable to protracted gestation, and that the same may be said of the decisions and even of the laws of other countries. Thus, the law of France does not allow the legitimacy of a child born after a gestation of 300 days to be disputed, and admits evidence as to more lengthened gestation.

The arguments in favour of a variable period and the possible protraction of gestation, then, are

1. The strong analogy of animals, whose period of gestation, like that of the human female, was originally supposed to be fixed, but which is now proved, by careful and extensive observation, to be subject to great variety, and to be much protracted beyond the assumed limit.

2. The analogy of other functions of the human body, and especially of menstruation and child-bearing, all of which present wide limits of variation in time and degree.

3. The absence of any exact conformity in the statements of those who advocate a fixed period, and deny the possibility of its extension.

4. The balance of authority, both ancient and modern, in favour of its possible extension.

5. The legal decisions and laws of our own and other countries.

6. (and this is the most conclusive). The facts founded on accurate observation in cases of a single coitus, or of sudden death, or separation.

These arguments must be admitted to have far greater weight than the general impression in favour of a fixed period. But, though they render it in the highest degree probable that the period of utero-gestation may fall short of, and extend beyond, 280 days, the degree to which it may be lengthened out must still remain a subject of discussion.

This question, of the extent to which the period of utero-gestation may be protracted, assumed a definite shape in the celebrated Gardner Peerage Case, of which the following is a brief outline.

In the month of March 1796, Alan Hide Gardner, afterwards Lord Gardner, then a captain in the navy, was married to Miss Adderley. They cohabited together as man and wife from the time of their marriage until the month of January 1802 (except during the occasional

* For the precise statements of these authorities, see the article Succession, by Dr. Montgomery, himself a firm believer in protracted gestation, in the 'Cyclopædia of Practical Medicine;' and for the opinions of older authorities, see Beck's 'Medical Jurisprudence,' article Legitimacy.

absence of the husband). On or about the 30th of January, Alan Hide Gardner took leave of his wife, and sailed a few days afterwards for the West Indies, and did not return to England until the 10th day of July in the same year, his wife remaining in England during the whole of that period. Towards the end of the year 1801, when Alan Hide Gardner was absent on his Majesty's service, his wife entered into an adulterous conversation with Henry Jadis, Esq., which Alan Hide Gardner did not discover until the month of June 1803; after which time he did not live or cohabit or have any intercourse whatever with his said wife. On the 8th of December, 1802, she was, without the knowledge of Alan Hide Gardner, delivered of a male child, which was afterwards baptized by the name of Henry Fenton Gardner. In Easter Term, 1804, Alan Hide Gardner brought his action in the Court of King's Bench against Henry Jadis, for criminal intercourse with Maria Elizabeth Gardner, and in that action obtained a verdict against Henry Jadis for 1000*l.* damages. He also obtained a sentence of divorce in the Consistory Court, and the marriage was subsequently dissolved by Act of Parliament. Alan Gardner, Baron Gardner, died on the 30th of December, 1808, leaving Alan Hide Gardner his eldest son and heir, who thereupon succeeded to the barony, and became the second Baron Gardner. On the 10th of April, 1809, Alan Hide, Lord Gardner, was married to the Honourable Charlotte Smith, daughter of the Right Honourable Robert Lord Carrington, and by her had issue Alan Legge Gardner, his only son, who was born on the 29th of January, 1810, and one daughter. Alan Hide Lord Gardner died on the 22nd of December, 1815, leaving Alan Legge Gardner his only surviving son, who succeeded to the title. Henry Fenton Gardner attained the age of twenty-one years in the month of December, 1823. Alan Legge Gardner, being an infant of the age of fourteen years or thereabouts, petitioned his Majesty for a recognition of his right to the title by letters patent, or by ordering his name to be entered on the Parliament Roll as a minor peer.*

It was proved on the trial that there was a possibility of access on the 30th of January, from that date to the 7th of February, and on or after the 11th of July. Hence the three questions proposed to the medical witnesses:—

1. Could a child born on the 8th of December have been the result of sexual intercourse either on the 30th of January, or anterior to it, being 311 days?

2. Could a child born on the 8th of December have been the result of sexual intercourse on the 7th of February, or anterior to it, being 304 days?

3. Could a child born on the 8th of December, and living to manhood, have been the result of sexual intercourse on or after the 11th

* This account is taken, with alterations, from Le Marchant's history of the case.

of July, a period of 150 days, or two or three days short of five calendar months?

The first two of these questions may be reduced to one, and we shall have the following alternative:—if the child were legitimate, he must have been either a five months' child, or, to speak more correctly, a 150 days' child, or a 304 or 311 days' child (one calendar month and two or nine days beyond the *usitatum tempus pariendi*).

The latter alternative, viz., gestation protracted to the 304 or 311 days, was the one chiefly insisted upon in this celebrated trial.

Of the medical witnesses who were examined, the majority gave their evidence in favour of protracted gestation; a small number of influential names was ranged on the side of a fixed period. As the opinions of these latter authors have been already stated, and the subject of protracted gestation has been discussed at as great length as is consistent with the limits of this work, the reader is referred for further particulars to Dr. Lyall's pamphlet.* The decision of the case did not turn upon the medical evidence, but upon the adultery of the mother of Henry Fenton Jadis. The claim of the petitioner, Alan Legge Gardner, was allowed.

2. VIABILITY OF CHILDREN.

The question, What is the shortest period of gestation at which a *viable* child may be born? was raised in the Jardine case, which, though less known than the Gardner Peerage case, is equally interesting, as no less than 14 medical men, and a still greater number of non-professional witnesses gave their evidence. In this case, too, there was great difference of opinion among the medical witnesses. The evidence of Drs. Alison and Christison was admitted, simply because as Lecturers on Forensic Medicine, their attention had been directed to the question involved; and it may be safely affirmed, that the evidence of the last-named witness, Dr. Christison, threw more light upon the case than that of all the other witnesses put together.

The following is a short abstract of this case:—

The defendant was married on the 3rd of March, 1835; and on the 24th of August following, his wife was delivered of a girl. Supposing this child to have been the fruit of sexual intercourse on the day of the marriage, it was only 174 days, or five calendar months and twenty-one days old. The infant, which was undoubtedly immature, though the degree of immaturity could not be ascertained or determined, died on the 20th of March, 1836, having survived, as nearly as possible, seven months.

The libel charged the defendant with having committed fornication

* 'Medical Evidence relative to the Duration of Human Pregnancy, as given on the Gardner Peerage Case.'

with his wife before marriage. A great many witnesses were called, some to establish the possibility of sexual intercourse before marriage others to show that the child, though small and feeble, was not immature, or at least not so immature as the date of the marriage, would make it; and others to speak to the impossibility or improbability of a child surviving at that early period. The extent to which the allegations of the libel were made good, and the vague nature of the evidence adduced in their support, will be best seen by the following extract from the decision of the Presbytery, November 7, 1838: "That the testimony of the several witnesses, both with respect to matters of fact, viz., the appearance of the child at birth, &c., and also with respect to the opinions of medical men regarding the viability of such a premature child as the child in question is said to be, is of such an opposite and contradictory nature, that the Presbytery, with their present light, have great difficulty in coming to any decision on these points. The Presbytery, therefore, agreeably to a common maxim of law, *Satius est impunitum relinqui facinus nocentis quam innocentem damnari*, find the libel not proven." *

The principal points established by the general and medical evidence in relation to Mrs. Jardine and her infant were, that she had menstruated as usual the week previous to her marriage; that she was, both before and after her marriage, in a very weak state of health; that she was herself a seven months' child; that she had a second child, a daughter, which she believed to have been born "just about the commencement of the eighth month of her pregnancy," and that she had not provided baby-linen for this child. As regards the infant, the evidence, though contradictory on many points, showed that it was small (it weighed three pounds when born), very feeble, and decidedly immature, though no data were adduced to show the degree of the immaturity. It required to be nursed with care, but none of those precautions for preserving the child's warmth, such as wrapping it in wool, causing an adult female constantly to sleep with it, or to keep it in her arms, were taken, which seem to have been absolutely necessary in the cases of Drs. Rodman and Outrepont, presently to be described.

The special question raised in the Jardine case was this—Could a child born 174 days, or five calendar months and twenty-one days after marriage, be reared to the age of seven months? and the more general question which the case suggests is—What is the earliest period of gestation at which a viable child may be born? or, in other words, what is the earliest period of gestation at which a child has been born, and has survived its birth so long as to prove that there was no physical obstacle to its attaining the adult age?

* 'Record of the Proceedings in the reference by the Synod of Fife, to the Venerable the General Assembly of the Church of Scotland, in May, 1839, of the Case of Mr. Thomas Barclay, Town Clerk, and Nine of the Parishioners of Kinghorn, against the Reverend Fergus Jardine.' Edinburgh, 1839.

Now it is universally admitted that a child may be born and reared to manhood at the seventh and eighth, as well as at the ninth month. All authorities are agreed as to the possibility of a child of seven calendar months living to manhood; it is only, therefore, with regard to periods anterior to this that any doubt exists. On the other hand, in spite of the case of Fortunio Liceti, said to be born at four and a half months, and to have lived to 80, we may pretty safely affirm that a viable child cannot be born before five calendar months, or 150 days. Our attention, then, will have to be directed to the periods of five and six months, and it may be useful, in this place, to give a short tabular summary of the leading particulars of the cases which are best attested, and most worthy of confidence. In the cases of Outrepont and Belloc, the age stated is that at which the children were last seen alive by the reporters.

Table showing the Lengths and Weights of Children reported to have been born during the 5th and 6th Months of Gestation, with the assumed Age and the probable Age, according to the Estimates and Observations given at pages 66, 67.

Author.	Length.	Weight.	Survived its Birth.	Asserted Age.	Age according to Estimates and Observations.
	Inches.	lb. oz.		Days.	
Rodman . .	13 at 3 weeks.	1 13	1 yr. 9 m.	133	Possibly 5 months.
Outrepont . .	13½	1½ 0	8 years.	175 or 189	6 months.
Belloc . . .	12¾	..	17 years.	6 months.	Possibly 5 months.
Bucholtz* . .	14	1½ 0	2 days.	189 days.	6 months.
Kopp † . .	12½	2 0	4½ days.	182	6 months.
Fleischmann ‡.	11½	1 5	8 days.	168	Possibly 5 months.
Christison § .	13	1 7	8½ hours.	167	Possibly 5 months.
Mr. Thomson ‖	12½	1 8¾	3½ hours.	5 months.	5 months.

This table is certainly confirmatory of the views of the reporters of the several cases: there is not one of the cases in which the asserted age does not correspond pretty closely with the estimates and measures

* Beitrage, ii. 104.
† Jahrbuch, iii. 128.
‡ Henke's 'Zeitschrift,' vi. 12.
§ Evidence in the Jardine case.
‖ Of Alva, Stirlingshire, quoted by Beck, p. 212.

already given, and, in some cases, the observed weights and measures might have belonged to an earlier period of gestation.

If now we revert to the Jardine case, we find a weight of 3 lbs. stated to belong to a child born at 174 days, or before the completion of the 6th month, which weight is a pound in excess of any of the weights given in the table. It also exceeds the weights given at p. 66, with the exception of the very doubtful instance of 3 lbs. 13 oz.

Though the lengths and weights contained in the above table afford a strong probability that the estimated periods of gestation in some, at least, of the cases is the true one, that probability requires to be confirmed, by contrasting the other particulars of their histories with the acknowledged signs of immaturity.

The following are the signs of maturity and immaturity, according to Foderé and Capuron.

The signs of maturity are the following:

The ability to cry as soon as the child reaches the atmospheric air, or shortly thereafter, and also to move its limbs with facility and more or less strength; the body being of a clear red colour; the mouth, nostrils, eyelids, and ears perfectly open; the bones of the cranium possessing some solidity, and the fontanelles not far apart; the hair, eyebrows, and nails perfectly developed; the free discharge of the urine and meconium, a few hours after birth; and, finally, the power of swallowing and digesting, indicated by its seizing the nipple, or a finger placed in its mouth.

The signs of immaturity, on the other hand, are the following:

The length and volume of the infant much less than those of an infant at full term; it does not move its members, and makes only feeble motions; it seems unable to suck, and has to be fed artificially; its skin is of an intense red colour, and traversed by numerous bluish vessels; the head is covered with a down, and the nails are not formed; the bones of the head are soft, and the fontanelles widely separated; the eyelids, mouth, and nostrils closed; it sleeps continually, and must be preserved by artificial heat; and, lastly, it discharges its urine and meconium imperfectly, and often after a long interval.

The presence of the membrana pupillaris, the high position of the centre of the body, the non-descent of the testicles, the large size of the head as compared with the body, the great prominence and deep red colour of the parts of generation, and the absence or scanty deposit of sebaceous matter on the skin, may be mentioned as additional signs of immaturity.

By comparing this description with some of the more remarkable recorded cases, it will be seen what degree of probability attaches to the estimates of authors. Only two of these cases are here selected for consideration, viz., those related by Dr. Rodman of Paisley, and Dr. Outrepont.

Dr. Rodman's case is as follows:

After describing the mother as "more cautious in her decisions, accurate in her observations, and steady in her deportment, than what is usually met with in society," and stating that she had borne five children, and "was confident that the period of her gestation was less than nineteen weeks," Dr. Rodman says, that premature labour came on in consequence of fatiguing exertions, and she was delivered of a living male infant.

"Not daring to allow the washing of the infant's body, he was speedily wiped and wrapped in flannel, with only an opening in the dress around his mouth for the admission of air; and by the time the dressing was over, the mother was ready to take him into the warm bed with herself. It is common, if there be much apparent weakness, to feed a child the first twelve hours after birth very frequently, yet, in this instance, although the child was weak, no feeding was attempted till beyond that time; the nourishing heat with the mother in bed was relied on. On the following day, the head, body, and extremities of the child were surrounded with fine cotton-wool, pressed to appear like cloth, to the thickness of two or three folds, and over that the flannel as before; and again the child was given to the mother in bed. His vital energy was so deficient, that even with this dress, of himself he was unable to support the degree of warmth which was necessary to his existence. The heat of a fire was evidently injurious, as he soon became weaker when exposed to it, whilst the warmth of the mother in bed enlivened and strengthened him. Too much heat induced a sickly paleness of his face, with an obvious expression of uneasiness in his countenance; and the abstraction of heat, even by tardily undressing his head, brought on a nervous affection, or starting of the muscles all over his body. From seeing how these morbid affections were induced, the child was kept regularly and comfortably warm, by the mother and two other females alternately lying in bed with him for more than two months. After this he could be left alone from time to time, but was still undressed very cautiously and only partially at any one time. It was not till the child was three weeks old that the length or weight of the body could be ascertained. The *length* was found to be 13 *inches*, the *weight* 1 *lb.* 13 *oz. avoirdupois.* It was extremely difficult to get the child to swallow nourishment the first week; the yellow gum soon came on, and the thrush seized him severely on the eighth day, and was not cured till the end of the third week. During the first week he was fed with toasted loaf bread boiled with water, sweetened and strained through fine linen; in the second week twenty drops of beef-tea were added to the two or three teaspoonfuls which he took of this nourishment, and small doses of castor-oil were administered. At the end of three weeks he began to swallow teaspoonfuls of his mother's milk, and in two days afterwards he made exertions to suck. His mother's milk was gradually substituted, at least in part for the panada, though this was still continued occasionally with a few drops of port wine.

Under this careful management he attained the age of four months, at which time his health and excretory functions were peculiarly regular."

Five months after this, as we find from a second paper by Dr. Rodman,* this little child was still doing well. In this paper he confirms what he had stated in the first: he describes the mother as tall, robust, and healthy, and states that she had a peculiarly accurate knowledge of the time of her previous gestations, and does not hesitate still to affirm, that the period in this instance was rather under nineteen weeks.†

Dr. James Hamilton, in his evidence given in the Jardine case, states that this infant lived a year and nine months, and consequently was a viable infant; but that from the facts of the case, and some circumstances communicated in a correspondence with Dr. Rodman and himself, he had always been impressed with the belief that there was some mistake in the woman's reckoning, and that the infant was a dwarf. Dr. Hamilton adds that the infant was considerably smaller than those puny infants born within the six months, whom he had seen drag on a miserable existence for four or five days.

It must be admitted at once that, in this instance, an extremely feeble and immature child was reared by very judicious treatment. It cannot be denied, too, that the estimate of the child's age, formed by the mother, was at least as likely to be correct as such estimates ever can be, and the degree of doubt which attaches to the case is only such as attaches to a mother's estimate of the age of a child. The length and weight of the child, too, are in keeping with the other lengths and weights given in the table at p. 123, and they will be found to coincide with the extreme weight and length of the tables at pp. 66, 67. The absence of any description of the appearances presented by the child prevents us from determining, with any approach to accuracy, its degree of immaturity. It might have been a five months' child, but there is no ground for supposing it to have been born before the completion of the fifth month.

The case related by Dr. Outrepont, of Bamberg, is a very valuable one, for it is the only quite unequivocal instance hitherto published, of the rearing of a six months' child. The particulars are given so fully, and with such precision, that even Hencke, who previously denied the possibility of such an incident, has candidly admitted that Outrepont's case is an unequivocal example.‡ The evidence is as complete as it is possible to be in any case of the kind. It is complete both as derived from the date of the mother's impregnation, and as drawn from the structure and history of the child. The mother, a

* 'Ed. Med. and Surg. Journal,' vol. xii.

† Case of a child born between the fourth and fifth month, and brought up. By John Rodman, M.D., Paisley, 'Ed. Med. and Surg. Journal,' vol. xi. p. 445. The facts of this case were attested by Mr. White of Paisley.

‡ 'Zeitschrift,' vi. 27.

young woman, whose catamenia had always been perfectly regular, menstruated as usual ten days after her marriage, and subsequently to this time was repeatedly connected with her husband. About a fortnight after this menstruation, she underwent a general change in appearance, and began to have frequent attacks of vomiting and fainting, symptoms which she never had in her life before. These symptoms continuing the catamenia did not return: and about twenty weeks after their last appearance, she felt the first movements of the child. Five weeks after this, and twenty-seven weeks (twenty-five?) after the last appearance of the catamenia, she was seized with labour-pains, and uterine hæmorrhage; upon which Dr. Outrepont having discovered that the hæmorrhage proceeded from the placenta being attached over the os uteri, encouraged the labour, and brought it forthwith to a prosperous conclusion. Here the evidence of the child being not more than twenty-five weeks old, is as strong as in the nature of things it is reasonable to expect. The state of the child at birth is still more unequivocal. It was a boy, and breathed immediately on being born. It measured thirteen and a half inches, and weighed one pound and a half. Its skin was covered with smooth lank down, and was much wrinkled. The whole extremities were extremely small in proportion to the trunk, and were kept constantly bent over the body, as during the existence of the fœtus in the womb. The nails of the fingers and toes were like mere white folds of skin, the testicles were still within the belly, and the pupillary membrane was entire. The child whined, but could not cry—slept almost constantly—awoke only once a day—seldom opened its eyelids, and was obviously insensible both to light and sound. The first excretion of urine took place on the seventh day, and the first evacuation of the bowels on the ninth. Subsequently the urine was voided once in forty-eight hours, and the fæces every two or three days. It was placed in a basket filled with wool, kept in a uniform temperature, and moved with great care. For some time it was fed with the spoon on diluted milk and sugar. In four weeks the down began to drop off from the skin. In fifteen weeks it had made very little progress in any respect. The wrinkles had disappeared, however, from the skin, and the length was increased an inch and three quarters. But from this time, which corresponded with the fortieth or forty-second week after impregnation,—that is with the full period of utero-gestation,—it made rapid advances; sleeping less, eating more, crying strongly, and becoming evidently sensible to sound, and pleased with the light. When fourteen months old, it was of the weight and stature of a child born at full term. In the eighteenth month, the testicles descended into the scrotum, without causing him any annoyance. In like manner, the teeth began to appear early in his third year. He did not begin to walk till half a year later; and at that time differed from other children of the same age, not only in littleness, but likewise in the singularly old

expression of his countenance. When Dr. Outrepont saw him in 1816, he was eleven years of age, was as big as a boy of seven or eight, and had just begun to read and write.*

The length and weight in this case are also in keeping with the lengths and weights in the table at p. 123, and are much within the extremes given in the tables at pp. 66, 67. The signs of immaturity are also so well marked and so minutely described as to be decisive of the possibility of rearing a child born at the end of the sixth solar month, or about twenty-six weeks.

Having discussed at length the two great questions connected with the subject of legitimacy, it will be necessary to say only a few words on some questions of less interest and importance.

The question of paternity, as has been already stated, may arise where a woman, soon after the death of her husband, marries a second time. Sometimes this question assumes the shape of the one last discussed. A child is born within five months, or thereabouts, of the death of the first husband, and the question of paternity becomes one of viability. Where the child is of such an age as that it might have had either husband for its father, the question of paternity must be decided by a reference to the state of health of the deceased husband at the presumed time of conception.

Another class of questions, of little importance and rare occurrence in this country, may arise in slave-holding states, where the reputed parents of a child are of different colours, and the offspring differs in appearance from the majority of children of mixed marriages.

Some discussion has taken place as to the kind and degree of evidence of live-birth which may be necessary to establish a right of inheritance under the tenure known as 'tenancy by the curtesy.' "When a man marries a woman seised of an estate of inheritance, and has by her issue born alive, which was capable of inheriting her estate. In this case he shall, on the death of his wife, hold the lands for his life, as tenant by the curtesy of England." It appears that the meaning of the expression *born alive*, is not the same in this case as in cases of infanticide. It has been decided that in questions of tenancy by the curtesy, any kind of motion is evidence of live-birth. Thus, in the case of Fish *v.* Palmer, tried in 1806, "a twitching and tremulous motion of the lips" was held to be sufficient evidence of live-birth.

The question, how far monsters are capable of inheriting, has been raised, and answered by Blackstone, who states that "a monster which hath not the shape of mankind," "hath no inheritable blood;" but if, in spite of deformity, "it hath human shape it may be an heir."

* This case is taken from Dr. Christison's evidence on the Jardine case, with alterations and additions suggested by the perusal of the case in the 'Zeitschrift, für die Staatsarz,' vi. 19. It may be well to state that Dr. Christison admitted the possibility of a child born after 174 days being reared.

CHAPTER IV.

LIFE-ASSURANCE. FEIGNED DISEASES.

LIFE-ASSURANCE.

THE medical man performs many important functions in relation to life-assurance. With the exception of the simple facts which the actuary obtains from mortuary registers as his materials for calculating common average risks, almost all his information respecting special risks, and the influence of particular diseases on the duration of human life must be drawn from medical sources.

Every well-conducted assurance office, moreover, employs a medical man to examine and report upon the state of health of all persons making personal application to the office, and, in other cases, intrusts the duty to some medical man chosen for the purpose. The ordinary medical attendant of the applicant is also consulted respecting his state of health and the diseases from which he may have suffered.

The services of the medical man are still more indispensable in the case of those offices which undertake the insurance of unsound lives. He is also employed by benefit societies to ascertain the state of health of persons applying for admission into them.

Similar services to these have also to be occasionally performed in examining emigrants and recruits.

The insurance offices generally provide the medical examiner with a printed list of questions, prepared under medical advice, or suggested by their own experience, relating to the state of health of the applicant, his family and personal history, his occupation and habits, the diseases which he has suffered, and such other particulars as are presumed to affect the probable duration of his life. Similar questions are drawn up for the guidance of the medical referee.

From this brief statement it will be seen that the duty of the medical examiner resolves itself into a work of inquiry and a work of personal inspection and examination, respecting both of which a few practical suggestions may be offered with advantage.

The inquiries which the medical examiner is expected to make relate partly to the family history and partly to the personal history of the applicant. The importance of the first class of inquiries rests upon the ascertained prevalence of hereditary predisposition whether of a favourable or unfavourable character. As a general rule, the children of those who have died at an advanced age themselves live to be old, while, on the contrary, the children of parents who have died young are likely to be short lived. Moreover, a considerable number of diseases which sensibly affect the duration of human life are transmitted

from parent to offspring, or, passing over one generation, from grandsire to grandson. The medical examiner should, therefore, begin by ascertaining whether the parents of the applicant are living or dead; and, if living, what age they have attained, if dead, at what age they died. This inquiry should be extended to the brothers and sisters, and in some instances to the uncles and aunts of the applicant. As a general rule it will not be necessary to extend the inquiry beyond the father and mother and the brothers and sisters of the applicant, if the answers respecting them prove favourable; but if these near relations have died early, or if they appear to be subject to some hereditary malady seriously affecting the duration of life, it may be necessary to include in the inquiry a larger circle of relationship. Having ascertained the ages of the living and deceased members of the applicant's family, the medical examiner should next inquire into the causes of death in the case of those deceased members of the family who have not died of old age. If one or more should be found to have died of pulmonary consumption, asthma, insanity, gout, or disease of the heart; or of apoplexy or dropsy at an early age; the fact would have to be noted as more or less seriously affecting the value of the life under examination; and similar importance would attach to the ascertained prevalence of any of these diseases among the living members of the applicant's family.

From the family history of the applicant the examiner would pass to his personal history, which would comprise his age, his social relation (whether married or single), his occupation, place of residence, and habits of life, and the diseases to which he has been subject, not forgetting to ascertain whether he has had small-pox, or been vaccinated. Among the diseases or symptoms of disease to which the greatest importance attaches may be mentioned spitting of blood (as affording a strong probability of consumption); gout, acute rheumatism, and asthma (as both liable to recur and as laying a foundation for serious organic changes); dropsy (as a common result and indication of severe organic mischief); inflammation of the lungs (as leaving behind it some unfavourable change in those organs, or as being the direct consequence of tubercular deposit); fits (as betraying serious lesion of the nervous system); rupture (as involving danger of strangulation); and calculous disorder (as obviously tending to shorten life).

The personal examination will have to be conducted with greater or less care and minuteness as the family and personal history have proved favourable or otherwise. A favourable personal and family history will justify a cursory inspection and examination. If the person is well formed; the complexion healthy; the pulse regular and equal, of fair force, and not exceeding 70 or 75, or falling much below 60 (in the female not more than 80); and if the breathing is free and tranquil, further inquiry will be unnecessary. If, on the contrary, the family or personal history is unsatisfactory; if the person is ill formed or disproportioned, if the pulse is frequent or

otherwise abnormal, and the respiration unnatural, and especially if the applicant has been attacked by any serious disease, a more minute examination directed to the condition of the nervous system, of the lungs, or of the heart, will be required. In the examination of the chest, percussion and auscultation should be employed, and in examining the lungs the spirometer of Dr. Hutchinson may be used with advantage.*

To these general observations on the duties of the medical examiner such short statements as are consistent with the narrow limits of this work respecting the influence on longevity of place of residence, change of climate, occupation, and habits of life, of peculiarity of constitution, of hereditary predispositions, and of pre-existing disease, may be added with advantage.

Place of Residence.—The principal facts which have been ascertained respecting the place of residence of persons living within the limits of their native country are the following:—That the inhabitants of the rural districts are longer lived than the inhabitants of towns. 2. That large cities are more fatal to life than small ones. 3. That marshes, and the low-lying districts on the banks of rivers, are less healthy than more elevated spots. 4. That of two districts of equal elevation that which has a sandy or gravelly soil is healthier than that which consists of clay or rich alluvium. 5. That close, damp, and ill-drained houses are peculiarly fatal to life. Such considerations as these ought, in extreme cases, to influence the medical examiner in selecting lives for assurance. It is obvious that the inhabitant of Glasgow or Liverpool has not so good an expectation of life as the inhabitant of London, and a much worse expectation than a resident in the country; that a residence in London on the south side of the Thames entails greater risks than a residence on the north side;† and that the tenant of a close, damp house is not so good a life for assurance as a man who occupies a spacious, dry, and well-built residence.

Change of Climate.—The removal from a temperate or a cold climate to a hot one, or the reverse, affects the duration of life much more seriously than any change of residence from one part of a man's native country to another. Our insurance offices, accordingly, either refuse to insure lives at all in extreme cases, or demand additions to the usual rate of premium, varying with the ascertained or estimated increase of risk. The most precise information which we possess in reference to this subject is drawn from the reports of the mortality of our troops and seamen employed in different parts of the world; from which it appears that while the difference between low

* For a description of this instrument, with directions for its use, tables of reference, and the indications which it affords, the reader may be referred to Hooper's 'Physician's Vade Mecum,' 5th edition, p. 162.

† The deaths in London per million inhabitants, on an average of fifteen years, have been as follows:—West districts, 3,676; Central Districts, 4,402; North districts, 4,670; East districts, 5,435; South districts, 6,535.

and damp situations and dry and elevated ones prevails in every part of the world, the risk to life increases with the temperature, attaining its maximum within the tropics, and falling to the standard of England, or even below it, in cold or temperate regions. Some assurance offices, acting upon this general principle, allow the assured to reside without extra charge in any part of the world lying beyond thirty degrees from the equator, requiring from those who take up their abode within these limits an extra payment roughly proportioned to the additional risk.

Occupation.—The occupations which have been proved to affect injuriously the duration of human life are those which lead to excessive indulgence in spirituous liquors, those which combine sedentary habits, or a minimum of exertion, with exposure to a close and heated atmosphere, those which entail undue exposure to the weather with hardships and privations, those which require long hours of work, and a sacrifice of natural rest, those which are carried on in clouds of dust, and those which bring men in constant contact with poisonous substances. The employments which demand special mention, as belonging to these several heads, are licensed victuallers, potboys, and brewers' draymen; compositors, tailors, and drapers' assistants; soldiers and sailors during active warfare; bakers; knife and needle grinders; house-painters, manufacturers of cards enamelled with lead, and men who work with mercury, phosphorus, or the salts of arsenic. One occupation not easily brought under any of these heads has been shown to shorten life without causing an undue amount of sickness, namely, the employment of the butcher.

The most important of the above employments, in its bearing on life-assurance, is that of the licensed victualler, whose life is very generally looked upon with suspicion, and even deemed uninsurable in the absence of very distinct proof of temperate habits.

Habits of Life.—Luxury, sloth, dissipation, and intemperance, are all of them very fatal to human life; but the last is the only one of which it is easy to obtain distinct proof. When the fact of intemperance is clearly established it affords ground for the peremptory rejection of the life. It is also well ascertained that unusual risk attends the assurance of the lives of persons living in a continual state of pecuniary difficulty and embarrassment.

Peculiarity of Constitution.—Under this head it will suffice to notice the scrofulous constitution; the long neck and narrow chest so common in consumptive patients; and the short neck, florid complexion, large chest, and tendency to corpulency of the victims of apoplexy.

Hereditary Predisposition.—The most important of hereditary predispositions in relation to life-assurance is pulmonary consumption, a disease which destroys one in seven of the entire English population, and more than one in four of the adult population of the metropolis, being peculiarly fatal to men following sedentary occupations, and to persons of dissipated and intemperate habits. The inquiries of the

medical examiner should be especially directed to discover traces of this disease in the family history, and great importance should be attached to the occurrence of several deaths from this cause among the nearest relatives. Insanity, gout, asthma, urinary calculus, disease of the heart, dropsy, and apoplexy, especially when they appear to have caused the death of more than one member of the family at a comparatively early age, are also deserving of the serious attention of the examiner.

Pre-existing Disease.—The medical examiner will have to form his own estimate of the influence which previous attacks of disease may have had upon the health of the applicant and the value of his life. As a general rule, it may be stated that the febrile exanthemata which make their attacks chiefly in childhood, and the typhus or typhoid fever of the adult, do not permanently affect the value of life. Attacks of erysipelas must be viewed differently, as this is a disease very apt to recur. The same remark applies to attacks of gout, acute rheumatism, and asthma, and in a very peculiar manner to attacks of pulmonary consumption, a disease which often proves fatal after several distinct attacks. The importance of the symptom of spitting of blood, as affording a probability of a previous attack of consumption, has been already insisted upon. But the medical examiner ought to bear in mind that vomiting of blood from the stomach may have been confounded with spitting of blood from the lungs; and that even where there is no room to doubt that the blood was brought up by an effort of coughing, it may have come from the throat, or from some slight abrasion of the lining membrane of the windpipe. Even when the blood is shown to have come from the lungs it may have been the result of some great exertion immediately preceding it, or, in the absence of such explanation, it may have accompanied the formation of bronchial polypus, or resulted from the discharge of an aneurism into the air-passages. In this latter case, the symptom would be still more formidable than if it had resulted from tubercular disease of the lung itself. The quantity and colour of the blood alleged to have been discharged by coughing are points of the utmost importance. The expectoration of a considerable quantity of vermilion-coloured blood would always constitute a sufficient ground for the rejection of a life; but a scanty expectoration of blood, whether light or dark coloured, should always lead to a minute and careful examination of the chest. If inflammation of the lungs, or other severe disease of those organs, or repeated attacks of bronchitis, figure in the previous history of the applicant, there would be the same reason for submitting the chest to careful examination; for these diseases are not only important in themselves, but may be the result of tubercular deposit, on the one hand, or may lay the foundation for mortal diseases of the heart on the other. Repeated attacks of bronchitis, for instance, may be expected to occasion emphysema, and to be followed by hypertrophy of the heart.

If the medical examination into the applicant's family and personal history, and into his existing state of health, should prove favourable, his life would naturally be recommended for assurance on ordinary terms; but if unfavourable, the somewhat difficult question arises whether the life should be altogether rejected or accepted on condition of a more or less considerable addition to the ordinary premium, or (what amounts to the same thing) on payment of the premium required for a healthy person of a more advanced age. Such adjustments can only be safely made by a medical man of sound experience and large medical knowledge; and it would be useless to attempt to lay down for the guidance of the examiner in this matter any rules, however general.

But the medical examiner may not only be required to give his advice in cases of insurance for the whole of life, he may also be required to determine the propriety of insurances on unsound lives for short periods, and to suggest the terms upon which they ought to be effected. Cases are of common occurrence in which it is of the utmost importance to effect an insurance for a short term, as of one or two years, upon a life which must be rejected if offered for the whole of life. A young person, for instance, who has already had symptoms of pulmonary consumption, and whose chest has been ascertained to be unsound, may desire to effect an insurance on his life for one year, and the medical examiner may have to report on the expediency of undertaking the risk. The considerations which would guide him in his decision are obvious. Pulmonary consumption may prove fatal in any one of a considerable series of years, and the chances against an attack of the disease falling in any particular year are considerable; and even on the assumption of its occurring in the year covered by the assurance, there is the favourable chance of its commencing its attack at a late period of the year, and either not proving fatal in that attack, or (as the disease in its fatal attack has an average duration of nearly two years) not having a fatal issue till long after the period covered by the assurance has run out. Similar reasonings apply to other severe diseases, and, with little modification, to the assurance of unsound lives. On this branch of the subject, too, it is not possible to lay down any precise rules. For forming a right decision upon this class of cases large professional knowledge must be combined with sound judgment.

On the purely legal bearings of the subject of life assurance little need be said. It is obvious that the contract entered into in a policy of insurance may be rendered void by any intentional concealment or omission of such particulars of the previous health or habits of the applicant as, if known, must have caused the life to be rejected, or accepted only on more onerous terms: also by omitting to name the medical men who have attended him in any serious illnesses. But even where there has been no fraudulent concealment, questions have been raised as to the tendency of particular diseases, such as indigestion, gout, or mental unsoundness, of accidental injuries, such as fractures, and of

particular habits, such as smoking and opium-eating, to shorten life. On all such questions there is much room for difference of opinion among even well-informed medical men.

The definite questions now commonly prepared for the guidance of the medical examiner, and the experience of insurance offices of the difficulty of obtaining a verdict in their favour, except in cases of undoubted fraud, tend greatly to limit the number of actions at law, and to deprive this subject of some of the legal interest which it formerly possessed. But the importance of the subject in every other point of view, and the value of the services of the medical examiner and referee, is on the increase as the value of the assurance of life and health becomes more fully appreciated, and the practice of insurance proportionally extended.

FEIGNED DISEASES.

Though feigned diseases are not of very great importance in a legal point of view, and though cases of imposition rarely occupy the attention of our higher courts of law, the subject is one which very properly finds a place in a medico-legal treatise.

Diseases and disabilities are feigned from a great variety of motives. The soldier or sailor pretends to be ill to escape from duty, or to obtain his discharge from the service, and the mendicant to avoid labour. Sickness is often feigned to obtain parochial relief, or to impose on private benevolence; to defraud benefit societies; to procure the comforts of an hospital; to obtain compensation for some pretended injury; to procure a release from confinement, or exemption from punishment: and there are many persons, particularly young and unmarried females, who, without hope of gain, feign diseases in order to excite public interest and curiosity, or private sympathy.

The persons most prone to feign diseases are those who congregate most; as soldiers, sailors, prisoners, beggars, and school boys and girls. But the best school for feigned diseases is the army, especially in countries where the conscription is in force. Thus Fodéré, speaking of the time when the conscription was in full force in France, says that malingering "was brought to such perfection, as to render it as difficult to detect a feigned disease, as to cure a real one."

In treating the subject of feigned diseases a classified list will first be given of the principal diseases and defects which have been feigned; and this will be followed by rules for their detection.

Classified List of Feigned Diseases and Defects.

It is difficult to form any classification of feigned diseases which shall be free from many objections. The most natural is into, 1. Diseases obvious to the senses; 2. Diseases and defects of a simple kind, not obvious to the senses, but depending upon the description of the impostor; and, 3. Diseases of a more complicated nature.

1. *Diseases obvious to the Senses.*

This class contains the following subdivisions. *a.* Increased and diminished size of parts. *b.* Malformations. *c.* Wounds, ulcers, and superficial inflammations. *d.* Discharges. *e.* Spasmodic affections. *f.* Paralytic affections.

a. Increased and diminished Size of Parts.—Tumours. A favourite mode of producing tumours is by injecting air beneath the cellular membrane—beneath the skin of the abdomen to imitate *ascites*, into that of the scrotum to imitate *hydrocele* and *hernia*, under the scalp to give the appearance of *hydrocephalus*, into various parts of the limbs, with the assistance of ligatures, to imitate local swellings. This imposition may be detected by the touch, and by uncovering the tumour and searching for the aperture through which the air has been introduced, which aperture is generally found covered by a small piece of plaster. Tumours are also produced by pressure. Swellings on various parts of the limbs, *anasarca*, *varicose veins*, and an appearance resembling *elephantiasis*, have been produced by ligatures; and *œdema* of the upper extremity by hanging the limb over the back of a chair previous to the medical visits. In such cases marks of the pressure will be discovered on careful search. *Tympanites* has been imitated by swallowing air, or drinking large quantities of chalk and vinegar. In such cases, a solution of Glauber's salts with weak tobacco-water has proved very efficacious in the hands of Dr. O'Hara. The appearance of an abdominal tumour has also been produced by forcibly elevating the spine at the loins whilst lying on the back. Tumours have also been imitated by the use of substances extraneous to the body, as *polypus of the nose*, by means of the testes of a cock, or the kidneys of a rabbit retained in the nostril, and sometimes impregnated with fœtid juices. Strong sternutatories will assist us in unmasking these cases. *Hæmorrhoids* have been imitated by the bladders of rats or small fish partly introduced into the rectum; *Prolapsus ani* by the gut of an ox or of a sheep, or by the everted anal extremity of the bowel of a colt or hog. In one case mentioned by Percy and Laurent, prolapsus ani was actually produced by passing into the anus the bladder of a sheep, distending it with air, and forcibly retracting it. *Prolapsus uteri* has been imitated by similar means; *Hydatids* of the uterus by vesicles prepared from the intestines of a pig; *malignant tumours* by a sponge soaked in various colouring matters; and *Hernia* has been feigned by the injection of air, or by the forcible retraction of the testicles towards the rings. *Cancer* has been imitated by a cow's spleen, and by a sponge moistened with milk, and fixed under the armpit. *Swellings of the Joints,* intended to represent white swellings, have been produced by various acrid plants, as the ranunculus acris and ranunculus sceleratus, applied to the part. Enlargement of the abdomen in the female has been simulated by a pad. *Partial Atrophy* may be produced by pressure.

The frauds contained under this head only require, for their detection, a careful examination of the part itself, by the eye and by the touch.

b. Malformations.—*Lateral curvature of the spine* has been imitated. This simulated deformity is always in the dorso-lumbar region; the curve always single; the convex side not gibbous; there are folds of skin, generally two in number, on the concave side; and the haunch of that side is raised so as to give to the extremity the appearance of being shortened. In morbid deviations, on the contrary, the seat of curvature is variable; there is more than one curvature; the convex side is gibbous; the folds of skin, if present, are very slightly marked, and there is little or no inclination of the trunk, or elevation of the haunch. *Gibbosity,* or *elevation of the shoulders, wry neck, hip-disease,* and *various contractions of the limbs or joints,* are imitated by obstinate and long-continued flexion of the part, aided by inaction and the use of tight bandages. Sometimes the contraction is attributed to a burn or previous injury, in which case a wound is made to bear out the assertion. More commonly these contractions are attributed to a previous attack of rheumatism. In these cases there is generally ground for suspicion when there is no cicatrix, and no atrophy of the limb, but on the contrary, tension, hardness, and swelling of the contracted muscles. Many means have been proposed for the detection of this class of impositions; such as compressing by a tourniquet the nerves supplying the contracted muscles; applying a wet bandage tightly round the limb, which, when dry, may so compress the muscles as to prevent the continuance of their contraction; endeavouring to move the limb during natural sleep, or during that produced by narcotics; the examination of the limb during the sickness and weakness produced by an emetic, or by intoxication, or, better still, by chloroform; the electric shock; gradual and repeated tension of the contracted limb by means of a pulley or weights; making a sudden extension whilst the attention is engaged; applying the actual cautery should that remedy be indicated in the real disease; or recommending the warm climate of the coast of Africa as a cure. In some cases the most effectual method of all is to treat the deformity as a matter of no importance, not requiring surgical treatment. *Dislocations* may be effected intentionally. Those of the shoulder-joint and patella are the most easily accomplished. *Fractures,* when real, are often prevented from healing by frequent motion, leading to the formation of false joints.

c. Wounds, Ulcers, and Superficial Inflammations.—*Mutilation* is a very common practice in the army, and especially in regiments submitted to very strict and harassing duties. In countries in which the conscription is in force, the practice is carried to an extraordinary extent. This is the case in France, and to a still greater extent in Egypt, in which unhappy country, it is stated to be difficult to meet with a single unmutilated male adult. *Wounds.*—The distinction between wounds self-inflicted and inflicted by others, or taking place

accidentally, will be considered under the head of wounds. *Bruises* have been imitated by colouring materials, but not being true to nature they are easily detected by the experienced eye. *Ulcers* are among the most common of feigned diseases, and when they exist naturally they are often intentionally increased. The means most commonly resorted to are corrosive acids and alkalies, caustics, corrosive sublimate, arsenic and its sulphuret, copper wire, acetate of copper, blistering plaster, quicklime, the flame of burning bodies, the ashes and chewed leaves of tobacco, the vegetable acrids, especially the ranunculus acris and sceleratus, the mezereon or spurge-laurel, the euphorbium, the arum maculatum, and the juniper. Ulcers are also excited by mechanical means, as by pressure and friction—pressure by pieces of copper coin, and friction by sand. Occasionally in place of being produced or increased by the use of irritants, ulcers are imitated by gluing a portion of a spleen or the skin of a frog on the part, the surface being kept moist by a sponge dipped in blood and water. The most common situation of these factitious ulcers is the lower extremities. Factitious ulcers may often be detected by simple inspection of the surface and dressings, or by a closer examination with the lens. The sudden increase of inflammation on and about the ulcer will naturally excite a suspicion of the use of irritants; and the healthy appearance of the impostor will often be found at variance with the extent of ulceration. In hospitals, when there is ground for suspicion that an ulcer is prevented from healing by the use of irritants, a wooden box completely enclosing the leg has been used with the best effect. *Fistula in Ano and in Perineo* have been imitated by a punctured wound into which a tent covered with some irritating substance, or made of the root of the milk thistle, or of white hellebore, is introduced. A variety of *cutaneous diseases* have been feigned, or intentionally produced, as *lupus* by the application of pounded garlic, and the juice of the euphorbium; *erysipelas* by a short application of blisters; *urticaria*, by eating shell-fish; *psoriasis* and *impetigo*, by the use of strong rubefacients; *pompholyx*, by blistering plaster; *scabies*, by punctures irritated with gunpowder; *porrigo*, by nitric acid dropped upon the hand, and by other irritants; as also by a paste composed of rancid butter, honey, sulphur, and a small quantity of the powder of cantharides; *baldness* has been effected by the use of nitric acid. *Variola* in its eruptive stage has been imitated by punctures into which bay-salt and gunpowder were afterwards rubbed. The discolouration of the skin in jaundice has been imitated by a variety of colouring materials.

To this division belong certain affections of the eyes, which are obvious to the senses. *Ophthalmia* has been purposely produced by gonorrhœal matter, nitric acid, corrosive sublimate, sulphate of copper, nitrate of silver, lime, pepper, snuff, the smoke and juice of tobacco, salt, alum, the powdered root of euphorbium, a blast of cold air, cantharides, friction, and the introduction of fragments of cloth or

muslin. The counterfeit disease is generally confined to one eye, and that the right: its progress is very rapid, the swelling and inflammation are chiefly in the conjunctiva, and cease when the vision becomes imperfect. The eye is rarely so much disorganized as in the real ophthalmia. Factitious ophthalmia, when it occurs in the army, is apt to attack only the privates and non-commissioned officers. The use of irritants in the form of powder can often be detected, as in the case of ulcers, by simple inspection. *Ophthalmia tarsi* has been simulated by the use of strong irritants, or by the extraction of the eyelashes. A healthy aspect of countenance would lead us to suspect the fraud which had been practised, as ophthalmia tarsi rarely occurs in any but the scrofulous and cachectic. *Opacity of the cornea* has been caused by dropping strong acid into the eye, or by introducing a fragment of lime or of some other strong irritant. *Cataract*, too, has been produced by the introduction of a fine needle through the cornea to the lens.

d. Discharges. *Vomiting* is a frequent factitious symptom of disease. It is effected by pressing on the pit of the stomach, by swallowing air, by a strong and sudden action of the abdominal muscles assisted by tickling the fauces, and by the use of emetics. The matters rejected from the stomach are common water, urine, and even fæces, all of which had been previously swallowed. The larva of insects have also been mixed with substances stated to have been vomited. Factitious vomiting is generally unaccompanied by emaciation, and the fraud is often readily detected by the absence of the other concomitants of those diseases of which vomiting is a symptom. *Diarrhœa* and *dysentery*, too, are often feigned or produced at will; feigned, by breaking down an ordinary evacuation and mixing it with urine; produced, by a mixture of vinegar and burnt cork, by a solution of the sulphate of iron, by drastic purgatives, or by the introduction of irritating substances into the rectum. The evacuations are sometimes tinged with blood procured by puncture, laceration, or strong suction of the gums, or they are coloured of a dark red by logwood, green by senna, and black by deep-coloured wines. A careful examination of the evacuations, the use of a separate close-stool, the inspection of the linen, and a comparison of the symptoms present with those of the simulated disease, will assist in discovering the fraud. *Ascarides* have been clumsily imitated, as in an out-patient of King's College Hospital, by pieces of thread, one of which was red. A species of lizard was placed in the evacuations, in a case related by Dr. Spence. Alterations in the secretion of *urine* belong to this division. Alleged urinary concretions have been found to consist of sand, pebbles, and pieces of quartz and flint. Fragments of brick or slate, and small pebbles, have been introduced into the urethra to bear out the alleged existence of urinary calculus; and calcined bricks, coals, and fragments of bone have been introduced into the vagina with the like intention. Mere inspection assisted, in some cases, by chemical tests, will serve to

unmask such impositions. *Hæmaturia* has been simulated by the use of beet-root, madder, cochineal, the Indian fig, the fruit of the prickly pear, and logwood; blood has also been injected into the bladder, or mixed with the urine after it has been passed, or it has been obtained from the mucous membrane of the urethra by scratching. Hæmaturia may also be caused by substances taken internally, as savin, cantharides, and turpentine. The urine may be tinged of different colours by substances taken internally, such as madder, logwood, indigo, rhubarb, black cherries, the whortle-berry, the pulp of cassia fistula, elder rob, and ferrocyanate of potass, or of iron. Milk has been added to the urine to give it a white colour. In all suspicious cases, the patient should be made to pass urine in the presence of the medical man. The absence of the local and constitutional symptoms attending the more severe affections of the kidney and bladder would naturally excite suspicion, and assist the diagnosis. *Gonorrhœa* has been imitated by the use of caustics; the *menstrual discharge* by staining the linen with bullock's blood; and *Epistaxis* has been produced by incisions. *Hæmoptysis* is a favourite factitious disease. It is imitated by holding in the mouth a sponge filled with blood, by incisions on the inside of the mouth or back of the throat, by pricking the gums, or by blood sucked from other parts of the body; or pastilles coloured with carmine, Armenian bole, brickdust, or vermilion, have been used for the same purpose. In suspicious cases, the mouth should be carefully examined, and rinsed out with water, the rejected fluid inspected, and, if necessary, analyzed: the chest also should be examined. *Hæmatemesis* is simulated by swallowing the blood of some animal. *Otorrhœa* is simulated by honey, pus, rancid tallow, asafœtida, or old cheese, introduced into the meatus: it has been excited by cantharides, or by irritating liquids. *Ozœna* has been imitated and excited by similar means. *Fœtid breath and perspiration* have been produced by oil of dippel, asafœtida, old cheese, putrifying fish, and the rancid oil from a cart wheel. Emetics in the one case, and ablutions in the other, with careful watching, will serve to detect the imposture.

e. Spasmodic affections. This class of diseases is frequently and successfully feigned. *Epilepsy* is the disease generally chosen for imitation, as it has the peculiar recommendation of being assumed at such times as suit the impostor's convenience. In addition to the violent struggles which form the prominent feature of the true disease, impostors have contrived to inflict bruises upon different parts of their persons as evidence of former attacks, to vomit blood previously swallowed, to imitate the foam at the mouth by chewing soap, and to discharge the urine as if involuntarily. As in the true epileptic seizure there is an entire absence of sensibility, the feigned disease is readily detected by any harmless infliction of pain, or by the use of some powerful stimulant. The stimulants commonly recommended for this purpose are, the vapours of hartshorn, or of sulphur, snuff, pepper, or asafœtida, applied to the nostril; a few drops of alcohol

or turpentine poured into the eye; a solution of aloes and salt, mustard, or common salt, placed in the mouth; hot water, or actual flame applied to the skin. Sharp-pointed instruments have sometimes been introduced into the flesh, but without detecting the imposition. The mechanical stimulus least objectionable, and most likely to be effectual, is the flecking of the naked feet with a wet towel or handkerchief. Other diagnostic marks between the true and the fictitious epileptic seizure might be mentioned; but they are of little value in comparison with these direct tests. *Convulsions.* These irregular actions of the muscles have been rife in all ages, partly as the result of involuntary imitation, and partly as the consequence of imposition. They are most frequent in females; but are by no means confined to that sex. The chief difference between real and feigned convulsions is that the real may be continued for a long time with comparatively little exhaustion, while the factitious soon occasion fatigue. To discover the fraud "it is sufficient to act with force on the antagonist muscles." (Orfila.) The impostor may also be tired out by long watching. Two cases of pretended local convulsive movements have come under the notice of the author. In one case the muscles of the abdomen were the seat of the contortions; in the other the muscles of the shoulders. *Chorea.* This, like other forms of convulsion, has often been the offspring of fanaticism, of involuntary imitation, and of voluntary deception. It is more easily feigned than epilepsy. When skilfully imitated the diagnosis is not easy, and many of the distinctions laid down in books are without foundation. Cold affusions and electricity, which may be used with propriety in true chorea, are not pleasant remedies for impostors, and are therefore greatly to be commended. *Hysteria.* It is of little consequence whether an attack of hysteria be feigned or not: cold affusion, which is the best remedy for the real disease, is not a pleasant application in feigned attacks. Whether it cures the real disease or leads to the fictitious one being laid aside is a matter of little moment. *Catalepsy* is a very rare disease, and its existence, especially in a male, may fairly justify some degree of suspicion. Powerful stimulants, the proposal of the actual cautery while the finger is on the pulse, appending a weight to the extended limb and cutting the string suddenly, have been recommended and practised with effect in feigned cases. Attempts have been made to feign *tetanus and hydrophobia* but they were unsuccessful. The fingers have been forcibly contracted, and the nails driven into the palm of the hand. By wearying the muscles with a conical piece of wood the imposition is readily detected. *Stammering* is often feigned. The best distinction is founded on the fact, that true stammerers hesitate little or not at all in repeating what they know by heart, and in singing. *Strabismus, Nictitation, and Blepharospasmus* are unimportant and easily pretended. *Dysphagia,* when feigned, may be cured by the persevering use of the probang. The suspected person should be narrowly watched. *Stricture of the urethra* has been feigned, but as the treat-

ment of the real disease is not agreeable, the imposition is not likely to be persevered in.

f. Paralytic Affections (*Hemiplegia*, *Paraplegia*, and *Local Paralysis*). In true paralysis, the parts affected are relaxed and emaciated, and their temperature is lowered. In paraplegia, the urine generally undergoes a marked change. These characters are not present in the fictitious malady. Every form of partial paralysis has been feigned. In paralysis of the fore-arm and hand, and more rarely of the entire upper or lower extremity, the discovery of a blue line on the gums would give good grounds for believing the paralysis real. *Paralysis agitans*. In attempting to imitate this disease the impostor generally overdoes his part. It is considered characteristic of the real disease that the patient in attempting to walk "is impelled unwillingly to adopt a running pace." The pretender, on the other hand, is apt to hesitate in his movements and to advance with difficulty. It happens fortunately in this, as in most diseases of this class, that the remedies proper for the disease are not agreeable ones; and where there is a good ground for suspicion, low diet will be found a useful auxiliary. *Ptosis*. The impostor generally makes attempts to prevent the raising of the eyelid, and this leads to detection. *Insensibility*, when feigned, may be detected by the use of stimulants, and the imposition will often be discovered by inconsistent statements as to the cause. *Coma and Lethargy* have been very successfully feigned, and in one or two instances the impostor has resisted every stimulant that could be thought of: in one case the operation of trephining caused merely a single groan. The treatment which we should be justified in resorting to if the complaint were real would prove a trying discipline to most impostors. *Syncope*. This scarcely admits of being feigned. for if the impostor can contrive to grow pale, he can scarcely control the action of the heart and arteries. More than one case, however, of a voluntary control over the circulation is on record, of which the best authenticated—that of Colonel Townshend—will be found in the chapter on Real and Apparent Death. Death itself has been feigned, and in one or two cases with such success as to deceive the common observer; and, in the solitary case of Colonel Townshend, so as to deceive medical men themselves. Poisoning has been feigned in some instances and imputed in others. The same rules apply to the detection of the first class of cases as to the detection of a feigned disease. We must compare the symptoms present with the known symptoms of poisoning generally, or of special poisons. Cases will also be given, under the heads of hanging and drowning, of the fraudulent disposal of a dead body so as that death may appear to have been due to those causes. Among prisoners unreal attempts at suicide by suspension or strangulation are very common. The attempt is usually made when assistance is known to be at hand. The feigned insensibility which follows is best unmasked by the electric shock.

2. *Diseases and defects of a simple kind not obvious to the senses, but depending chiefly upon the description of the impostor.*

The principal diseases belonging to this class consist in, *a*, increased and *b*, diminished sensation.

a. *Increased Sensation.—Pain.* This common symptom of disease is easy to assume and difficult to detect. External pain, such as tic-douloureux, often occurs in persons otherwise, to all appearance, healthy; and there are many pains of a severe character, of which the cause is extremely obscure. Many cases are also on record in which severe pain has arisen from a cause that has escaped observation, and the sufferers have been treated as if the pain were pretended. The nature of the pain, the appearance of the patient, the presence of the symptoms of disease with which it is ordinarily associated, and the consistent account given of its origin and progress, will assist us in distinguishing real from pretended suffering. But great caution and patience are necessary. Remarkable cases are recorded of submission to the most severe and trying remedies, and even to the removal of the breasts and limbs for simulated neuralgic affections. *Pain in the head*, and the giddiness which often accompanies it, are also easily feigned, and not easily proved to be so. No certain rules of diagnosis can be laid down in this class of cases; and in the case of pains in the head, as in pains in other parts of the body, real sufferings have been mistaken for pretended ones. *Rheumatic pains* in various parts of the body, especially in the loins and thighs, are often feigned; and, as they are not accompanied by any change in the parts affected, or by any well-marked constitutional symptom, with success. In many works on feigned diseases, long rules are given for detecting feigned pain, and the symptoms of almost every disease accompanied by pain are detailed with a minuteness as unnecessary as it is useless; for it may be stated as a general rule that feigned diseases of the more obscure class can be detected only by those who have extensive experience of real ones.

b. *Diminished Sensation.*—A diminution or entire absence of sensation is frequently pretended. *Amaurosis* is a favourite feigned disease, and is often produced intentionally. The substances employed for this purpose are the juice or extract of belladonna or hyoscyamus, the distilled water of the spurge laurel, and snuff moistened with a decoction of belladonna. The amaurosis produced by these means is not at first distinguishable from the real; but it disappears if the impostor be carefully isolated and watched. Of the perseverance with which the pretence of blindness is sometimes carried out, a case related by Mahon affords a good illustration. A recruit feigned blindness, and, after all other means had been tried without success, he was placed on the bank of a river, and ordered to walk forward, which he did. He afterwards confessed the imposture. *Myopia.*—Short-sightedness being a disability in the army is often feigned. It may be detected by placing an open

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book close to the face, or by requiring the suspected person to read print at some distance by the aid of glasses for the near-sighted. If the individual cannot read the book when thus placed, or when such glasses are used, we may be sure that the defect is feigned. *Presbyopia* is rarely feigned. The mode of detection is the converse of the preceding. *Amblyopia*, or weakness of sight, is also rarely pretended. In the army, the surest way to put a stop to these pretended defects, is to employ the subjects of them in some service for which the real defect would not unfit them. *Nyctalopia.*—Night-blindness. This disease is peculiar to warm climates, in which the sun's rays have great power. There are no satisfactory means of distinguishing the true from the feigned disease, as opposite states of pupil may exist in different cases. Here, too, it is useful to find for the real or pretended nyctalope some employment for which the affection, if real, does not incapacitate him. *Hemeralopia*, or day-blindness. This disease is not of much importance. It sometimes occurs for a short time as a symptom of worms, or of other intestinal irritation. The diagnosis will depend upon our knowledge of the disease of which it is a symptom. *Deafness.*—As this may occur without any change in the appearance of the external ear, it is a favourite imposition. The modes of detecting it are obvious. A watch should be set on the suspected person day and night, and things calculated to excite interest or apprehension should be said in his presence, and the effect be carefully watched. It has been recommended to place the hand on the pulse while any bad news, or threat of punishment, is being uttered. He should be called sharply or unexpectedly by name, or in a whisper, or he should be roused from sleep and spoken to, or a piece of money should be let fall close to him. All these, and similar tests, have often been applied in vain; sometimes, too, the loudest noises have not produced any apparent effect. In one case, related by Dunlop, a pistol was fired off close to the ear without effect; but upon the man being sent to sleep by opium, the imposition was detected on the repetition of the firing. *Dumbness.*—This is sometimes assumed with great perseverance. As a general rule it may be stated, that if a man not deaf can move his tongue he is not dumb. Nothing but complete paralysis can account for his being dumb. Some mutes add to pretended dumbness a feigned mutilation of the organ, which they effect by rolling the tongue back into the throat, and scratching it so as to make it bleed. A relative of the author's detected such an imposition in the case of a man who, by means of a written paper describing his captivity among the Algerines and his mutilation by them, had excited great commiseration. Pretending to give entire credence to the man's tale, and taking a half-crown out of his pocket, he requested the man to show him his tongue once more, upon which he thrust his finger suddenly against the root, and the tongue rolled out. *Deaf-dumbness.*—The combination of deafness and dumbness, though never occurring in a person previously in possession of both these faculties, is sometimes obstinately pretended. The impostor is

best made to lay aside his imposture by solitary confinement and low diet. In one or two remarkable instances, men who have pretended that they were born deaf and dumb, have resisted every test, and have been discovered only by those having personal experience of the really deaf and dumb.

3. *Diseases of a more complicated kind.*

In the two foregoing divisions those impositions have been considered which consist of a single appearance or outward manifestation, tangible or visible to the senses; or of a single alleged symptom or defect, not necessarily combined with other symptoms, or which, if sometimes forming part of a disease, deserve separate consideration. It now remains to speak of instances in which whole trains of symptoms proper to certain diseases have been assumed, with more or less success. This division consists of two classes: *a.* Diseases of the body. *b.* Diseases of the mind.

a. Diseases of the Body.—*Fever* may be either feigned or purposely excited. Foderé states, that he has often seen impostors produce an extraordinary frequency of pulse, accompanied with chattering of the teeth and profound sighs. Febrile symptoms may be excited by strong stimulants, such as wine, brandy, cantharides; and by the internal use of tobacco, which drug has a remarkable effect on the pulse; also by the introduction of a clove of garlic into the rectum. Violent exercise, or strong contraction of the limbs, or a heap of blankets, has been resorted to as a means of imitating fever. The tongue has been whitened by chalk, pipeclay, soap, flour, or whiting; and tinged brown by tobacco, brick-dust, liquorice, or gingerbread. Pallor of the skin has been imitated by the use of emetics, by smoking, by digitalis, or by drinking an infusion of cumin seeds. A flush, on the other hand, is produced by friction. The detection of cases of simulated fever is easy. The effects are always ephemeral, and all that is necessary is to have the patient watched for a few hours. *Ague* is often feigned, but not with much success. The effort necessary to imitate the rigors throws the impostor into a perspiration, which leads to detection. The shivering fit is not followed by the other stages. *Rheumatism.*—The acute form is not easily feigned; but the chronic form consisting chiefly in pain, and having no strongly-marked accompanying symptoms, has often been, as already stated, imitated with success. Various affections of the *chest* are assumed by impostors. *Pneumonia.*—In one instance mentioned by Dr. Gavin this disease was assumed, but not very successfully. The stethoscope would serve at once to prove its non-existence. *Phthisis.*—It would be difficult to deceive a careful observer, or one skilled in the use of the stethoscope; but many symptoms of the disease have been successfully assumed. Hæmoptysis and mucous expectoration have been imitated in the manner already described. Emaciation may be produced by abstinence, by drinking

vinegar, or by sucking a copper coin; febrile symptoms by the means just pointed out. *Asthma*, also, has been imitated, but here the stethoscope will assist in the detection of the imposition. *Apoplexy* cannot be successfully feigned. The fraud is easily detected by sternutatories, or by strong stimulants. *Dyspepsia.*—This disease is often feigned, and sometimes with success. Vomiting, gastralgia, pyrosis, and in fact all the symptoms of dyspepsia have been assumed, and the imposition has been detected only by careful watching. *Gastritis*, or acute dyspepsia, has also been assumed, but it is difficult to imitate it with success. Constant vomiting is not easily feigned, nor is the bright-red tongue, often present in acute gastritis. *Peritonitis*, too, has been imitated, but rarely with much success. In one case in which there was a pretence of great pain increased by pressure, a dose of opium was given, and the man bore very strong pressure without being roused from sleep. *Hepatitis* in its chronic form is a favourite feigned disease, as it is very prevalent in hot climates, and is supposed to be of very frequent occurrence in this country. The dull heavy pain in the right side is easily assumed, and the pain in the shoulder, but the discoloured eye and skin, the unhealthy aspect of the countenance, and the mental depression and listlessness not so readily. *Jaundice* has been imitated by staining the skin with an infusion of the root of curcuma longa, or of saffron, with tincture of rhubarb, the bruised seeds of the broom, or the stamens of the iris. Clay-coloured stools have been produced by taking a small quantity of muriatic acid, and the colour of the urine has been heightened by rhubarb. Attempts have also been made to pass off pebbles for gall-stones. It is not easy to tinge the conjunctiva yellow, nor to produce at one and the same time the yellow skin, the pale stools, and the high-coloured urine. It must be borne in mind, however, that in the real disease the fæces are not always pale, but that occasionally they contain an excess of bile. *Scurvy.*—One prominent symptom of this affection is often imitated, viz., the spongy and bleeding gums. For this purpose, various irritating substances are used, or the gums are punctured previously to the visit. As this is but one symptom, and the others are not easily feigned, this imposition will present but little difficulty. *Nephritis.*—The pain which accompanies this disease has been assumed, and the assertion has been borne out by the exhibition of pebbles or fragments of brick. It is scarcely necessary to state that it is almost impossible for an impostor to assume all the symptoms of nephritis.

Much more might be said on this division of feigned diseases, and minute rules for diagnosis might be laid down: but want of space, and the assurance that it is not by descriptions of diseases, but by actual experience of them, that the true are to be distinguished from the false, has led to the subject being thus briefly handled. Those who are familiar with treatises on this subject will know how much of false diagnosis they contain. In doubtful cases, a reference to the best description of the disease supposed to be assumed is strongly recom-

mended, but it must be borne in mind that symptoms commonly considered as of high diagnostic value may be absent in the real affection, and may lead to unjust suspicions.

b. Mental Disorders.—Feigned insanity is of so much importance that it will be treated in the next chapter under the head of unsoundness of mind.

The following general rules may render some assistance in distinguishing a feigned disease from a real one.

RULES FOR THE DETECTION OF FEIGNED AND FACTITIOUS DISEASES.

1. Inquire, in all cases, into the existence of motives for deception. Will the suspected person, by imposition, gain anything he desires, or escape anything he dreads? It should, however, be borne in mind that both men and women feign diseases from other motives than those of gain; and occasionally there is so complete an absence of all discoverable motive, that we are forced to believe in the existence of a moral insanity displaying itself in this way.

2. Inquire into the previous history of the patient, and the character he bears among his comrades or companions. It often happens that the impostor has been previously noted for dishonesty, and for practices similar to those of which he is suspected. But, in other instances, men of the best character, who have for years conducted themselves with propriety, have been convicted of malingering.

3. In the case of external diseases obvious to the senses, make a minute and careful inspection of the part itself, and examine it by the eye and by the touch. When there is a suspicion of the use of irritating substances, inspect the part narrowly with the aid of the lens, and search the pockets, boxes, or bed of the suspected party, and if necessary isolate him so as to deprive him of the assistance of others, and of his means of deception. Use equal care in inspecting substances alleged to have been discharged, and examine them, if necessary, by the microscope or by chemical tests. In cases of rigidity, anchylosis, or deformity, examine the suspected person when under the influence of chloroform.

4. When some defect, or disability not obvious to the senses, but depending entirely upon the assertion of the person himself, as pain, deafness, &c., is supposed to be assumed, we must endeavour to take him by surprise. In the case of pretended deafness, for instance, we must try to discover the imposition by sudden and unexpected noises, by speaking to the suspected person immediately on his being roused from sleep, or when his power of self-control has been impaired by opium or chloroform.

5. In cases of feigned diseases, properly so called, we must examine minutely into the history and alleged causes of the disease; compare the age, temperament, and mode of life of the suspected person with

the symptoms present; watch narrowly the course of the symptoms, and contrast it with the known march of the disease itself.

6. The suspected person should be visited at all hours of the day, and at times at which he does not expect to be seen; and he should be watched by those whom he is not likely to suspect.

7. The questions addressed to a suspected person should be of a nature to mislead him: they should be so framed as to lead him into the assumption of symptoms foreign to the malady which he is simulating. By concealing the suspicions really entertained, and foretelling, in the hearing of the suspected person, the advent of symptoms which do not belong to the assumed disease, the malingerer may often be made to betray himself.

8. Observe whether the suspected person is willing to make use of the medicines and measures prescribed for his relief. The impostor is generally less disposed to resort to the necessary means than he who is really ill.

9. Great caution is necessary in the treatment of suspicious cases. As a general rule, no measures ought to be employed which would not be justifiable on the supposition of the disease being real. But when there seems to be strong ground for suspicion, low diet, isolation, and nauseous medicines may be fairly resorted to. When the disease supposed to be assumed is one which does not affect life (such as spasmodic twitchings of the muscles), it will often suffice to treat it with indifference, and to dissuade the suspected person from having recourse to medical treatment. Persons who wantonly abstain from food will generally desist if allusion is made in their hearing to cases of prolonged abstinence; and those who refuse to take exercise may be influenced by being placed on a lower diet.

Closely connected with the subject of feigned diseases is that of disqualifying diseases. It is chiefly interesting to military and naval surgeons; but cases occasionally occur in civil life in which the medical man is required to state his opinion. He may be directed to ascertain whether an individual is fit to serve on a jury; whether he is able to attend as a witness; whether he is competent to take on him certain offices or duties; or whether he can bear hard labour, or other severe punishment, which he may be sentenced to undergo. The medical man may also be called upon to ascertain the state of health of persons wishing to effect insurances upon their lives, and of children presenting themselves for admission into some of our public schools. The subject of exemption on the ground of disqualification in civil and criminal cases scarcely requires, or admits of, any precise rules; and disqualification for military service is a subject of too great extent to be treated of usefully in this place. There is the less necessity for its introduction here, inasmuch as the military surgeon is required to possess some work on his recruiting duties. The foregoing observations on feigned and factitious maladies apply equally to *malingerers* in the army and *skulkers* in the navy as to impostors in civil life.

CHAPTER V.

UNSOUNDNESS OF MIND.

The occasions on which the medical man may be required to give evidence as to the condition of the mind are very numerous. A man makes a will, and his relations dispute its validity: was the testator, at the time of making the will, in full possession of his faculties? A man squanders his property, or is accused of so doing: is he competent to manage his affairs? A man or woman contracts an unsuitable marriage: was the party possessed of such an amount of intellect, or in such a state of mind, as to give a valid consent to the contract? A criminal, or a person under accusation, makes a confession: was he in a sound state of mind when he made it? An act of great atrocity is committed: is the man who committed it in such a state of mind as to make him responsible for his act? A criminal is supposed to feign insanity in order to escape from the consequences of his crime: is he really of unsound mind? That these questions are of frequent occurrence may be inferred from the fact that the ascertained number of persons of unsound mind in England and Wales does not fall much short of 35,000. The medical man may be summoned to give evidence on the state of a person's mind before any of our courts of law, civil, criminal, or ecclesiastical; before commissions technically designated *de lunatico inquirendo;* and in the case of pauper lunatics, before the magistrate. He may also be called upon to sign certificates of unsoundness, at the instance of private persons, with a view to provide for the safe custody of those who are either unable to take care of themselves, or so afflicted as to be dangerous to society.

All inquiries into the state of the mind are surrounded by peculiar difficulties—difficulties partly inherent in the subject itself, partly due to the requirements of the law. The difficulties inherent in the subject itself arise, in part, out of the great original differences between mind and mind, the various degrees of development which they derive from education, and the equally various degrees of restraint to which they are subject in each period of life. Other sources of difficulty are to be found in the purely inferential character of our knowledge of the human mind, in the inapplicability to it of the method of experiment, in the want of any recognized standard of sanity, and in the necessity under which we are all placed of erecting our own mental experience into a standard to which to refer the operation of other minds. Minds thus different in original power, and in acquired habits, are known to be variously affected by the same physical and moral causes, and to be

subject to many distinct forms of disease displaying themselves in language and acts of the most various character. Some part of the difficulty which surrounds this subject is also to be attributed to the undue importance formerly given, in works on the human mind, to one or two of its higher faculties. The reason and the imagination were put so prominently forward, and the emotions and passions were made to play so subordinate a part, that soundness and unsoundness of mind came to be regarded as almost synonymous with a sound or erring reason; imagination had to bear all the blame of misleading the judgment; and delusion became the favourite test of insanity.

A more simple and practical theory of the human mind, recognizing the existence of several distinct faculties, has now taken the place of the narrow speculations of the older metaphysicians; and this theory of separate faculties, originally of different power in different persons, more or less improved by education and habit, under greater or less restraint from without or within, subject to different degrees of excitement; from causes acting within the body itself or from without, sometimes alone and sometimes in combination, is the theory which best agrees with reason and experience, offers the readiest explanation of the almost infinite variety of character, the endless diversities of opinion, and the strange eccentricities of conduct prevailing among mankind, and is most in harmony with what we know of the unsound mind.

The difficulties due to the requirements of the law originate in part from the lawyer's necessary ignorance of the unsound mind, the narrow views which have been handed down to him upon the subject, and the arbitrary selection of tests difficult, if not impossible, of application. The medical witness is accordingly often asked to define that which is properly a subject of description, and is tortured with questions which if he ventures to answer according to his belief, he lays himself open to the charge of presumption, if not of impiety.

In discussing the subject of unsoundness of mind, it is important to premise that it is not possible to frame a single definition of that state, nor to present a just view of it in a single description. For mental unsoundness assumes many shapes, and admits of many divisions and subdivisions, with a corresponding nomenclature. In searching after a just classification and an appropriate nomenclature, it is desirable to adopt, as far as practicable, the divisions and names sanctioned by legal usage. Wherever, then, the law defines with precision the meaning of the terms it uses, those terms will be preferred; and where no fitting word has been provided characteristic of a given state of the unsound mind, that will be employed which is in most common use by the best medical authorities.

In searching for a term proper to designate all departures from the more usual state of the mind, we necessarily encounter the words "mad" and "insane," descriptive of the person affected, "madness" and "insanity," descriptive of the state of the sufferer. These terms

might be adopted at once if they were commonly employed as the exact opposites, respectively, of the words "sane" and "sanity." But they are generally used in a restricted sense, as applied chiefly to those deviations from the healthy condition of the mind which consist in excessive and disproportioned activity, and are rarely, if ever, applied to those states of mind characterized by deficient energy of action, whether original or acquired. It is necessary, therefore, to make choice of terms which, being in less common use, may be more easily restricted in their meaning. Such are the terms "Unsoundness of mind" applied to the condition of the mind itself, and "Non compos mentis" applied to the person whose mind is affected.

But even these two terms are not free from objection, for the term "Unsoundness of mind" has not been always employed by legal authorities in a strict and limited sense. In the Portsmouth case, for instance, Lord Eldon spoke of unsoundness of mind as a state requiring to be distinguished both from idiocy and lunacy, and in many statutes it is found associated with the words Idiot and Lunatic.

The term "Unsoundness of mind," then, which seemed so simple and intelligible, is open to serious objection: but as it is to be preferred to the term Insanity, or to any other in common use, it has been placed at the head of this chapter.

The other term, "Non compos mentis," applied to persons who are of unsound mind, has been used by legal authorities with much greater consistency, and should be employed in preference to all others.

Having thus made choice of a term comprehensive enough to include all deviations from a sound condition of the mind, we have next to inquire what the law includes under this term, *non compos mentis*, what forms of unsoundness it recognizes, and how far it may be consistent with our knowledge as medical men to adopt a subdivision in accordance with the legal terms in most common use.

The common law of England originally included under this term only two forms of unsoundness, viz., Idiocy and Lunacy, but the highest legal authorities have acknowledged the necessity of more minute subdivisions. Thus Lord Coke recognizes four sorts of *non compos mentis.*—"1. *Idiota*, which from his nativity by a perpetual infirmity is *non compos mentis*. 2. He that by sickness, grief, or other accident wholly loseth his memory and understanding. 3. A lunatic that hath sometime his understanding, and sometime not, *aliquando gaudet lucidis intervallis*, and therefore he is called *non compos mentis*, so long as he hath not understanding. Lastly, he that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken."

We have here distinctly recognized three forms of unsoundness of mind, *Idiocy*, *Dementia*, and *Lunacy*, of which the first two alone are sufficiently well defined and understood to admit of being employed both by lawyers and physicians as part of a classification of the forms of mental unsoundness. The term lunacy is objectionable, inasmuch

as it directs attention only to one feature of certain forms of unsound mind,—the occasional enjoyment of lucid intervals. Since Lord Coke's time, little has been done towards a classification of the several varieties of unsound mind, though Lord Hale has plainly recognized the distinction between general or total, and partial unsoundness.

A legal writer (Stock), adopting the general term "non compos mentis" as including all forms of mental unsoundness, establishes a broad and just distinction "between those persons in whom the malady is the result of an improper inertness of the intellectual powers, whereby the mind fails to receive impressions; and those in whom it is the result of an improper activity, whereby the mind receives false impressions; a distinction between those in whom some most important mental functions, as perception and memory, are to a great extent or wholly wanting, and those in whom others equally remarkable, as the imagination and the feelings, are under excessive or misdirected excitement; a distinction, in other words, between that state which is well enough described by the term Fatuity, and that which is less accurately designated by the names of Madness, Delirium, Insanity, Mania, Lunacy, and many other words of very unsettled meaning."

The distinction here set forth is so in accordance with observation, and so convenient, that it may be fairly adopted as the basis of a classification of the forms of unsound mind.

The principal classes, with their subdivisions, are presented in the following table, which has been constructed after a careful comparison of the classifications adopted by different authorities.*

UNSOUNDNESS OF MIND.	FROM DEFECTIVE DEVELOPMENT, OR, DIMINISHED ACTIVITY OF THE FACULTIES.	Congenital, or occurring in childhood . .	Amentia	1. Idiocy.	
				2. Imbecility.	
		Occurring subsequent to the development of the faculties.	Dementia . . .	1. Consequent on Mania, mental shocks, or injuries of the brain.	
				2. Senile.	
	FROM UNDUE EXCITEMENT.		Mania	1. General.	
				2. Intellectual	a. General.
					b. Partial.
				3. Moral . .	a. General.
					b. Partial.

* See especially a work 'On the Arrangement and Nomenclature of Mental Disorders.' By Henry Johnson, M.D.; and a 'Treatise on the Medical Jurisprudence of Insanity,' by J. Ray, M.D.

As the subject of unsoundness of mind is one of vast extent, and embraces a great amount of details, a methodical arrangement of it is absolutely requisite. It is proposed to treat it under the following heads:—1st. Of certain unusual conditions of the mind not included under the general term mental unsoundness, and of the phenomena of dreaming. 2. Of certain conditions of the mind allied to mental unsoundness, but produced by temporary causes, viz. delirium, delirium tremens, drunkenness, and the effects of certain poisons. 3. Of the several forms of unsound mind, treated in the order in which they stand in the foregoing table. 4. Of some of the more important characters of the unsound mind, and of the medical and legal tests of that unsoundness. 5. Of feigned unsoundness of mind. And, lastly, Rules for the examination of persons supposed to be of unsound mind.

1. OF CERTAIN UNUSUAL CONDITIONS OF THE MIND NOT INCLUDED UNDER THE GENERAL TERM MENTAL UNSOUNDNESS.

The subjects included under this head have a close connection with, and direct bearing upon, unsoundness of mind. Dreaming is very generally recognized as an analogue of insanity. Spectral and other illusions exist in most forms of mental unsoundness; and the acts of the somnambulist are occasionally such as to originate questions of a medico-legal nature.

Spectral illusions.—Some individuals have possessed the power of recalling at will impressions made on the senses, so as to place the objects before them afresh; others have enjoyed a still more enviable power of converting thoughts into sensations, if such an expression may be allowed; and others again, in moments of intense excitement, or under the influence of slight derangements of their health, have seemed to see or hear things which had no real existence.*

Spectral illusions, as has been just stated, are of common occurrence in some forms of mental unsoundness, and their presence serves to explain, at least in part, the obstinate belief by which the mind, in such cases, is possessed. Thus the author of a curious and interesting autobiography,† which receives strong confirmation from the statements of persons who have been similarly afflicted, says in reference to one of his many spectral illusions: "I imagined I was really present to *them ;* and that my not acknowledging it was a delusion, an obstinate resistance of the Divine will on my part. That of the two, the appearance of the bed, walls, and furniture, was false, *not* my preternatural impressions."†

* For examples, see Sir David Brewster's 'Letters on Natural Magic,' Sir Walter Scott's 'Demonology and Witchcraft,' and Brierre de Boismont 'On Hallucinations.'

† 'A Narrative of the Treatment experienced by a Gentlemen during a state of Mental Derangement,' page 63.

Spectral illusions, then, are common to men of sound and of unsound mind, the difference being, that the former do not believe in their reality, the latter do. The sane man corrects these false impressions by the use of the other senses, or by some effort of comparison, while the man of unsound mind neglects these simple means of undeceiving himself, or cannot use them; or if he is led to entertain any doubt, he dispels it by the help of his delusion. Thus, the author of the autobiography, whose unsoundness of mind took a strong religious turn, thought it *impious* to doubt.

The subject of illusions of the senses came into discussion in the recent case of Buranelli, and questions were put to the medical witnesses as to the proper definition of the terms *illusion* and *delusion*. The difference between them is best shown by the addition of three words to each:—an illusion of the senses, a delusion of the mind. It may be well to add that an illusion of the senses, if believed to be a reality, becomes a delusion of the mind. The term *spectral illusion* is synonymous with the word *phantasm*. The term *hallucination* might be dispensed with altogether. It is not needed; and as it means an error, blunder, or mistake, it has no proper place in descriptions of mental unsoundness. An illusion means a mockery, false show, or counterfeit appearance; and a delusion a chimerical thought. The word illusion may be applied, with equal propriety, to a sensation without corresponding object, to a transformed appearance of a real object, or to an internal sensation exaggerated or misinterpreted. But M. Brierre de Boismont uses the term hallucination to designate an unreal sensation wholly due to the action of the brain, and illusion to designate a real sensation exaggerated or distorted by the same operation. The single term illusion ought to suffice for both purposes.

Dreaming.—The phenomena of dreaming have a striking analogy to those of some forms of unsound mind. The external world being shut out, and the higher faculties of the mind being in a state of comparative inaction, illusions have all the vivid impress of reality, and the thoughts which pass through the mind produce the same impression as in our waking state. They also follow each other according to associations over which we have no control.

Many dreams are directly traceable to bodily conditions which are recognized in the waking state as productive of pain or uneasiness, such as an oppression at the stomach, a distension of the bladder, or an inflammation or irritation of the skin. Sometimes this uneasy sensation is distinctly perceived by the sleeper, but attributed to a wrong cause, and associated with imaginary events. Thus Dr. Reid relates of himself, that "the dressing applied after a blister on his head, having become ruffled so as to produce considerable uneasiness, he dreamt of falling into the hands of savages, and being scalped by them."

In other instances, the uneasy sensation gives rise to a dream which has no other relation to the sensation itself than that of being painful

or disagreeable. The most distressing dreams of this class are known as *nightmares*.

In another class of cases, the bodily uneasiness seems to have no other effect than that of bringing the mind into a condition favourable to the blending together of disconnected occurrences, sometimes recent sometimes remote, having nothing in common but the feeling of annoyance or discomfort.

We hear, perhaps, of a distressing accident; we have received some unpleasant news of an absent friend; and we have been concerned in some business which gave rise to anxiety: a dream takes place in which all these are combined together; we are ourselves connected with the accident; the absent friend is in our company; and the person with whom the business is transacted also appears on the scene.*

A curious fact has been observed with regard to dreams excited by one class of bodily sensations, viz., that the same sound which awakes the sleeper, occasions a dream that appears to occupy a considerable time. Thus, "a gentleman dreamed that he had enlisted as a soldier, joined his regiment, deserted, was apprehended, carried back, tried, condemned to be shot, and at last led out for execution. After all the usual preparations, a gun was fired; he awoke with the report, and found that a noise in an adjoining room had both produced the dream and awakened him."

The strong analogy which exists between the phenomena of dreaming, and of certain forms of unsound mind, is shown in the examples cited at p. 181.

The remarkable analogy between dreaming and insanity, and the way in which the one may pass into the other, is well illustrated by the case of a maniac, mentioned by Dr. Gregory, who for a week after his recovery was harassed, during his dreams, by the same rapid and tumultuous thoughts, and the same violent passions, by which he had been agitated during his insanity. The case of M'Naughton may perhaps be cited as bearing a close resemblance to one class of dreams. The refusal of his father to take him into partnership originated in his mind a sense of hardship and injury: the Roman Catholics, the Police, and the Tories, being successively the theme of newspaper abuse, and being also represented as guilty of acts of injustice, impressed his mind with the same feeling. Hence the long dream of years, in which the sense of public injury was transferred to himself, till he became the fancied object of political persecution.

The difference between dreaming and insanity is, that in the one, the senses are closed to outward objects; in the other, the evidence of

* 'Inquiries concerning the Intellectual Powers, and the Investigation of Truth.' By John Abercrombie, M.D. The reader is referred to this work for many instructive anecdotes referring to this subject; and for more full information on the physiology of the human mind, to the chapter on Mental Physiology and Pathology in the author's edition of Hooper's 'Physician's Vade Mecum.'

sense is disregarded, or the senses merely suggest trains of wild and fanciful association, objects truly perceived being perverted and misinterpreted by the help of the prevailing delusion. In dreaming, as soon as the person is roused from sleep, and the external world is again brought before him, all his illusions and delusions vanish; but the madman is in a waking dream, from which he is not to be roused.

Legal relations of Dreaming.—A question of criminal responsibility arises in those rare cases in which a man suddenly aroused from sleep kills another. Such was the case of Bernard Schedmaizig, who suddenly awaking at midnight thought he saw a frightful phantom, and receiving no answer to his challenge twice repeated, but imagining that the phantom was advancing upon him, and having altogether lost his self-possession, raised a hatchet which was beside him and attacked the spectre. It was found that he had murdered his wife. Ray also relates the case of two men, who being out over night in a place infested with robbers, engaged that one should watch while the other slept; but the former falling asleep, and dreaming of being pursued, shot his friend through the heart. A pedlar, who was rudely aroused from sleep by a passer-by, ran him through the body with the sword of a sword stick. He was found guilty.* In all such cases, the confused state of the mind on being suddenly aroused from sleep ought certainly to be considered as a mitigating circumstance.

Somnambulism.—This is a form of dreaming in which the senses and voluntary muscles participate; the one exercised with extraordinary acuteness on the subject-matter of the dream, the other obeying the mandates of the sleeper's will with unwonted precision. The somnambulist's mind during the dream is so concentrated upon one object, that his reason or fancy will accomplish that to which it was unequal during his waking hours. It is this complete attention to one object, too, which probably accounts for that extraordinary acuteness of the senses, that precision of movement, and that total absence of fear which marks the most astonishing feats of the somnambulist; such as walking on the edge of a precipice, swimming a rapid stream, or riding at full gallop. Sometimes the sleep-walker performs, at each recurrence of the fit, with all the precision of his waking hours, some routine duty.

Objects of sense presented to the sleep-walker, either produce no effect, or they are mixed up indistinctly with the dream which he is acting. In some cases, so complete is the mind's abstraction, that the loudest noises are unheeded; in others, those things only are attended to which harmonize with the existing train of thought. The somnambulist is either unconscious of what has occurred, or he remembers it as a dream. In some cases, that which has transpired in one fit of

* The first and last of these cases are quoted by Dr. Forbes Winslow in his 'Plea of Insanity in Criminal Cases,' the first from Dr. Pagan, the last from the 'British and Foreign Medical Review.'

sleep-walking is distinctly remembered in subsequent ones, but quite forgotten in the intervals.

The analogy already pointed out as existing between dreaming and insanity may be extended so as to embrace some cases, at least, of somnambulism; for in certain forms of both these affections there is a remarkable increase of talent; in both there may be a complete change of character; and it would not be incorrect to state, that there is an intellectual and moral somnambulism, as there is an intellectual and moral insanity.

The following cases may be adduced in support of this view. A Carthusian monk who, while awake, was remarkable for his simplicity, candour, and probity, walked almost every night in his sleep, and was a thief, and a plunderer of the dead. A pious clergyman, in his fits of somnambulism, would steal and secrete whatever he could lay his hands upon, and on one occasion he even plundered his own church. In one case the somnambulism took the form of suicidal mania. The paroxysms occurred every night, and watchers were required, as if for a patient labouring under an acute disease. He always attempted to escape; and one night having succeeded, he was found suspended by the feet, from the limb of a high tree.* The following case of homicidal somnambulism is quoted by Georget from an anonymous work. A monk late one evening entered the room of the prior of the convent, his eyes open but fixed, his features contracted into a frown, and with a knife in his hand. He walked straight up to the bed, as if to ascertain if the prior were there, and then gave three stabs, which penetrated the bed-clothes and a mat, which served the purpose of a mattress. He then returned with his features relaxed, and an air of satisfaction on his countenance. The next day, on being questioned, he confessed, that having dreamed that his mother had been murdered by the prior, and that her spirit had appeared to him and cried for vengeance, he was transported with fury at the sight, and ran directly to stab her assassin. Shortly after he awoke, covered with perspiration, and rejoiced to find that it was only a dream.†

Legal Relations of Somnambulism.—A question has been raised as to the responsibility of the somnambulist for acts committed during the paroxysm, and it has been attempted to be shown that, as that which is done during the fit is often only the accomplishment of a project formed while the party was awake, he ought to be held responsible. If this improbable assumption were true, the somnambulist would not be responsibile unless it could be shown that he was voluntarily accomplishing in the fit that which he had previously thought about; in other words, that he became a sleep-walker at will, which is an absurd supposition. If the question of responsibility should arise it should be shown that the sleep-walking was real and not feigned, and also that the accused was subject to these fits.

* 'A Treatise on the Medical Jurisprudence of Insanity.' By J. Ray, M.D.
† Georget, 'Des Maladies Mentales,' p. 127.

Ecstasis, or cataleptic somnambulism, which is nearly allied to hysteria, and almost invariably occurs in females, may be noticed in this place. For some interesting cases of it, the reader is referred to Dr. Abercrombie's work on the Intellectual Powers.

2. OF CERTAIN CONDITIONS OF THE MIND, ALLIED TO MENTAL UNSOUNDNESS, AND CAUSED BY DISEASE, OR BY THE OPERATION OF CERTAIN POISONS: NAMELY, DELIRIUM, DELIRIUM TREMENS, AND DRUNKENNESS.

Delirium.—This state of mind supervenes in the course of almost all severe febrile and inflammatory diseases, and especially of those which attack the internal viscera. It is a common sequence of severe accidents, and of surgical operations; and it often ushers in the fatal termination of chronic disorders.

The delirium of fever is generally preceded by pain and throbbing in the head, heat of the scalp, and flushing of the cheeks; but it sometimes makes its attack suddenly, without previous warning. In the first class of cases delirium is often preceded by dreaming. The patient talks in his sleep, and wakes up confused and forgetful; but when fully roused, he is collected, and so remains till the next slumber. By degrees this disturbed sleep passes into waking delirium. The patient lies on his back, dull and listless, with eyes half open, muttering to himself, unconscious of persons or things around him, and when roused scarcely recognizing them. As the disorder increases and the strength fails, the voice becomes more indistinct, the fingers are constantly picking at the bed-clothes, the evacuations are passed unconsciously, and the patient can no longer be roused to any effort of attention.

If delirium occurs at an earlier stage of the disease, or before the strength of the patient has been much impaired, the symptoms are somewhat modified. The eyes are bloodshot, and intently fixed as if on some object really present. The patient talks loudly and earnestly, tosses restlessly about in bed, and makes repeated attempts to leave it, sometimes escaping from the custody of attendants, displaying great strength and activity, and even committing acts of fatal violence.

In some cases, during attacks of delirium, the memory of things long past becomes wonderfully active, and languages which were quite forgotten are recollected and spoken with perfect fluency.

In fatal cases, delirium usually passes into coma, but occasionally it disappears some hours or days before death, and leaves the patient in full possession of his faculties.

Delirium is a leading and almost constant symptom of poisoning by belladonna, henbane, and stramonium; a frequent result of poisoning by other members of the class of narcotico-acrids; an occasional one in poisoning by the pure narcotics, and it may even occur from the operation of poisons belonging to the class of irritants.

Delirium bears a close resemblance to that form of unsound mind

which goes by the name of incoherence; and the distinction between the two is not always easily made, without some inquiry into the history of the case. Delirium, when not caused by poison, is a symptom of some well-marked bodily disease, while unsoundness of mind is rarely accompanied by bodily disorder, till it has lasted so long as to become associated with paralysis.

Legal Relations of Delirium.—Civil acts performed during an access of delirium are necessarily void, and criminal acts entail no responsibility. In determining the validity of wills made by patients labouring under diseases attended with delirium, the law has regard less to the proved existence of a lucid interval, than to the character of the will itself. If it be in keeping with the patient's known character, and in harmony with intentions expressed or instructions given when he was sound in mind and body; if the several parts of the will are consistent with each other; if no improper influence was brought to bear upon him; the will would be declared valid, even though the medical evidence threw doubts on the testator's capacity. On the other hand, in the absence of these conditions, the will would generally be declared invalid, in spite of the strongest evidence of the testator's capacity.

It is important to distinguish delirium, with intervals of perfect consciousness, from the calmness of demeanour sometimes assumed by patients labouring under strange delusions, the result of unsoundness of mind showing itself in the first stage of convalescence from fever or other acute disease; or as part of delirium tremens brought on by drinking. The distinction is easily made, when it is borne in mind that in the one case (delirium) the mind wanders during sleep, in the other case while the patient is evidently wide awake.

Delirium Tremens.—The delirium of drunkards is easily recognized by the peculiar form which the mental unsoundness assumes, and by the equally characteristic bodily symptoms, aided by the previous history of the patient; and, in most cases, by the prompt cure effected by the proper remedies—stimulants and opiates.

A patient suffering from delirium tremens is restless, sleepless, timid, suspicious, and cunning. He is subject to illusions of the senses, and fancies himself surrounded by hideous and loathsome objects, such as toads, serpents, and scorpions, and that he is persecuted by strange sounds and threatening voices; or he thinks that thieves or evil spirits are breaking into the house. When under treatment, he is suspicious of the persons in attendance, and is constantly endeavouring to make his escape; and, if not properly watched, may do violence to himself or others. Some patients display a painful eagerness to go somewhere, or do something upon which their minds are bent. The bodily symptoms consist of the tremor from which the disease derives its name, with a pale, cold, clammy skin, a moist, white, tremulous tongue, and a small weak pulse. The history of the case is that of a course of intemperance terminated by a short supply of spirituous liquor, or by some exhausting disease or surgical injury.

In the milder forms of the affection, the patient goes about as usual, answers questions collectedly, and converses rationally; but when left to himself, he is as one in a waking dream, speaking of things calculated strongly to excite the feelings and passions with a manner perfectly free from excitement.

Some cases of delirium tremens, however, are accompanied by strong excitement, so as to present the closest resemblance to cases of moral mania, the patient being impelled to acts of violence against himself and others by the most unfounded delusions.

This class of cases is most commonly brought about by a few days or weeks of continuous hard drinking; or they occur, as the result of a single debauch in men who have had previous attacks of mania, or of inflammation of the brain, or who have suffered from severe falls or blows on the head. Such cases as these while they last are not to be distinguished from cases of mania.

Prolonged abstinence, too close attention to study or business, and solitary confinement, sometimes bring on a state of mind closely allied to delirium tremens, and characterized like it by illusions of the senses of sight and hearing.

Legal Relations of Delirium Tremens.—As delirium tremens is a temporary form of unsoundness of mind produced by a peculiar exciting cause, its legal relations must be those of insanity, unless the nature of the exciting cause constitutes it an exception to the general rule. This it does not appear to do; for, though drunkenness has little effect on civil or criminal acts, delirium tremens is allowed to have the same effect as insanity itself.

Drunkenness.—The excitement which, in persons of sound mind, attends the indulgence in alcoholic liquors, is converted, in persons of unsound mind, into maniacal incoherence, not to be distinguished from mania arising from other causes, except by the history of the case and the evidence of the sense of smell. A craving after spirituous liquors constitutes, in some persons, a form of unsoundness of mind (dipsomania); while in other persons it is merely one of the leading symptoms of an existing mental unsoundness. In some cases the craving after alcoholic liquors assumes an intermittent character, showing itself only at intervals.

Legal Relations of Drunkenness.—Drunkenness has no legal effect on any offence to which it leads. It neither increases nor mitigates the penalties which attach to it. Drunkenness has even been deemed an aggravation of the offence. A drunkard's acts are therefore valid, unless it can be shown that the drunkenness was procured by another person with a view to an unfair advantage. The question of the responsibility of persons suffering from the disease now recognized as *dipsomania* must be decided by the same tests as are applicable in other forms of unsoundness of mind.

3. OF THE SEVERAL FORMS OF UNSOUND MIND.

On referring to the table at p. 152, it will be seen that the several forms of unsound mind resolve themselves into three leading classes—Amentia, Dementia, and Mania.

AMENTIA.

This form of unsoundness of mind comprises the two species, idiocy and imbecility, as well as those cases of originally defective intellect which are traceable to local causes and are known as cretinism.

Idiocy.—The best legal and medical writers agree in defining idiocy as a congenital malady, and the idiot as one "who from his nativity by a perpetual infirmity is *non compos mentis*." But some writers of both professions have used the term with less precision, evidently confounding the idiot with the victim of dementia, or even of mania. The time for such confusion of terms is now past, and there is a clear understanding that idiocy is a congenital absence or serious defect of all the faculties of the mind; but a state admitting of degrees, and, like other forms of unsoundness of mind, not allowing of strict definition.

Idiocy, in its lowest form, combines the extreme of bodily deformity with an existence purely vegetative. Such idiots seem devoid even of sensation, and would perish if not closely attended to. In a somewhat higher form there are sensations of heat and cold, of hunger and thirst, and just intelligence enough to indicate the commonest wants by signs. But these are equally helpless with the first class. A still higher class consists of those idiots who have sensation and consciousness, recognize familiar persons and objects, are susceptible of attachment, can move from place to place, are able to make known their wants by gestures and sounds, or even by words imperfectly articulated, can be made to acquire habits of decency, can learn to hum or sing, or even to perform the simpler operations of arithmetic, and are susceptible of a certain limited improvement of their bodily and mental condition under careful, assiduous, and skilful teachers.

As a general rule, idiots are deformed in body as well as stunted in intellect. They have small and misshapen heads, squinting eyes, large gaping mouths with thick lips, and other features ill formed and distorted. The limbs and trunk are also imperfectly developed, and their gait is awkward and unsteady. Their complexion is generally sallow and unhealthy. Some of their senses are altogether wanting, and others very imperfect. In a few exceptional cases, the head is of ordinary size and well formed, and the body is not distorted, but the expression of the face is that of complete vacuity.

Idiots who reach the age of puberty often display the sexual passion by offensive gestures and disgusting habits, and they are also subject to violent fits of passion, and sometimes commit acts of atrocious cruelty.

The Legal Relations of Idiocy, in the restricted sense here assigned to the term, are very obvious. The persons now described labour under complete civil disability, and are irresponsible.

Imbecility.—This term is here used to designate unsoundness of mind occurring in early childhood, as contradistinguished from that which is congenital. This distinction is in accordance with the legal definition of idiocy; and it has the advantage of separating the idiot who has no use of speech, in consequence of his brain at birth being so defective as to prevent him from being taught even to this limited extent, from those who, being born with a better conformation of brain, are able to acquire the use of speech. A distinguished writer on Mental Unsoundness, M. Georget, recognizing this distinction, describes the imbecile as persons who have some use of speech, and who display some indications of mind, of intellectual faculties, and of feelings and affections.

In strict propriety of language, perhaps, idiocy and imbecility should be equally characterized as congenital defects, of which the more marked (idiocy) makes itself soonest known, while imbecility is not recognized till the faculties have been tested by education and found wanting. It is also obvious that it is not possible to draw a sharp line of distinction between the idiot and the imbecile. The fainter shades of imbecility pass into the lighter tints of idiocy. But the possession or otherwise of the faculty of speech is the best distinction of which the nature of the case admits.

The majority of imbeciles exhibit intellectual as well as moral deficiency. They cannot acquire or retain knowledge; they cannot understand or appreciate the customs of society and laws human and divine; they cannot bring their emotions and passions under control, as men of sound mind are able to do. But there is a small exceptional class which exhibits intellectual deficiency without seriously offending against morality, and a larger class which combines the highest intellectual endowments with utter incapacity in the conduct of life. There is, therefore, an intellectual, a moral, and a general imbecility, as there is an intellectual, moral, and general mania.

The form of imbecility which is most common and most important in a medico-legal point of view is that which affects the intellect, the morals, and the prudential conduct of life. Persons who exhibit this threefold deficiency profit by education, so as to form and express simple ideas; to read, write, and count; and to become musicians, draughtsmen, or mechanics. They may even attain to proficiency in some one branch of knowledge, or some one accomplishment. But they do not profit by the opportunities afforded them in the same degree as their neighbours. They present great varieties of character. Some are fickle and changeable, and incapable of fixing their attention; others are methodical and persevering. Some of them are found fit only for the coarsest and rudest labours, while others are equal, with the assistance and guidance of others, to the conduct of business and

the management of property. Others know the value of money, and can give information on the matters with which they are conversant, but they are unequal to emergencies, and unable to sustain close conversation or argument. They are thoughtless, improvident, uneasy, and restless, and generally incapable of strong and steady attachment. Imbeciles are very common among the lower orders of society. They are found following occupations requiring little sense or skill. Their neighbours look upon them as weak and singular persons, and tease and torment them accordingly. Many of them become lazy, drunken, and dissipated; and some, under slight temptation, and very inadequate motives, break out into fits of ungovernable passion, and commit acts of theft, arson, rape, or murder. " They steal adroitly, and hence are considered as very intelligent: they recommence their offences the moment they are released from confinement, and thus are believed to be obstinately perverse." " They have no idea, or a very imperfect one, of society, laws, morality, courts, and trials; and though they may have the idea of property, they have no conception of the consequences of theft. They may have been taught to refrain from injuring others, but they are ignorant of what would be done to them if guilty of incendiarism or murder." " Their conduct is actuated solely by the fear of punishment, when capable of experiencing that sentiment, and by their own desires. Others have some notions of property, but neither a sense of morality, nor a fear of punishment furnishes motives sufficiently powerful to prevent them from stealing." Georget, from whose work, ' Sur la Folie,' these passages are quoted, says that " these beings of limited capacity furnish to the courts of justice, to prisons and scaffolds, more subjects than is generally supposed."

Imbecility, as has been already pointed out, is not necessarily of this general character, displaying itself at the same time in the intellect, morals, and conduct. It is sometimes partial, affecting only or chiefly either the intellectual or the moral character. There may be, on the one hand, an inability to acquire and apply knowledge in persons who have a due sense of right, act with integrity, and perform every social duty; and, on the other hand, an unusual power of acquiring knowledge, with judgment, fancy, and refined taste, but combined with feebleness of purpose, want of self control, inaptitude for business, disregard of duty, and want of common honesty. Such persons are known in society as weak, soft, easy, good-natured, well-meaning, good sort of people, and if possessed of brilliant talents, as having every sense but common sense. They are too easy to be just; too thoughtless to be honest. They have an instinctive horror of business, an aversion to their regular occupations, and a distaste for everything that wears the shape of a duty. They are utterly ignorant of the value of money, and the last use they make of it is to pay their debts. Each man among them has his own favourite form of extravagance, and his own mode of ruining himself. One calls an architect to his assistance; another an upholsterer; a third collects useful things which he never

uses, or displays a curious taste in worthless trifles. They are always forming acquaintances with unworthy persons, who find it worth their while to know and to flatter them. With all their easiness of disposition they have much warmth of temper and strength of passion. They are bad children, husbands, and fathers, because in these relations of life they have duties to perform. Throughout life they are weak, wavering, fickle, and self-willed, as children; the source of constant anxiety and misery to their families; the prey of designing knaves; the expected inmates of gaols, workhouses, and lunatic asylums.

These moral imbeciles remain at large, because the intellect being unaffected, they have no distinct delusions, and there is nothing apparently to prevent them from becoming, at any moment, useful members of society. As weakness of intellect is a necessary ingredient in the legal idea of imbecility, the attempt to prove such persons of unsound mind, in a court of law, must necessarily fail. That absence of moral sense, and corresponding want of self-control which is the essence of their mental malady, is to be proved only by the history of their daily life.

Imbeciles are sometimes as much under the dominion of childish fancies as maniacs are of delusions. A few years since a commission of lunacy was granted in the case of a young gentleman, aged 20, who was the slave of a childish fancy for windmills, with an aversion equally strong to watermills. Having been placed under control in a place where there were no windmills, he cut the calves of a child's legs through to the bone, and stated that he should have taken away its life, that he might be tried for his act, and removed from a place where there were no windmills. He had always been violent when thwarted in his fancy, had threatened his keeper and members of his family, and had more than once made preparations for committing murder. In this instance, childishness of fancy, insufficiency of motive, absurdity of act, and ignorance of legal consequences were strikingly combined.

Legal Relations of Imbecility.—In respect to this form of mental unsoundness, two distinct orders of questions may arise—questions of competency, and questions of responsibility.

The *competency* of imbeciles to form contracts, and the validity of them when formed, has, in more than one instance, engaged the attention of our courts of law. Persons of weak mind have been brought by improper influence to ally themselves in marriage, and the validity of such marriages has been successfully disputed, as in the case of Portsmouth *v.* Portsmouth, in which, as in other instances that might be cited, the proof of imbecility was not drawn from a few isolated facts, but from an investigation of the whole life, conduct, and character of the party.

The competency of imbeciles to manage themselves and their affairs is often called in question. As the conduct of life is partly dependent on a knowledge of such simple matters as the value of money, and

partly on judgment and discretion, inquiries of this class sometimes assume a very simple, and at other times a very complicated shape.

In rare instances men have been pronounced incapable of managing their affairs, on the ground not so much of general weakness of intellect, as of a defective knowledge of numbers and of the value of money. Two such cases are related by Dr. Abercrombie, in one of which the most prominent character was a "total inability to perform the most simple process of arithmetic," and in the other "a total want of the power of tracing relations both as to time and numbers." In the face of evidence showing that they had made much progress in their education, both were pronounced incapable of managing their affairs.

In a case of imbecility on which the author was called to give evidence, the patient did not know how many pence there were in sixpence or a shilling, or how many shillings in a sovereign; could not perform the most ordinary operation of arithmetic; was ignorant of the date, the month, and the year; did not know the name of the reigning monarch; could not recognize persons whom he had seen and conversed with only four days previously. His attention was aroused with the utmost difficulty, and could not be fixed to any one subject. His look was vacant, his dress peculiar, his gait awkward, his motions grotesque, his speech slow and hesitating. He used the same words and expressions again and again, repeated imperfectly the tasks and prayers of his childhood, and imitated the contortions of persons, like himself, subject to fits. Such a case could present no difficulty either to the medical witness or to the jury.

The more complicated and difficult class of cases arise in respect of persons who though they display many marks of imbecility, in childish ways, eccentric habits, violent passions, and cruel dispositions, are yet able to perform the simple operations of arithmetic, know the value of money, and can comprehend such statements and suggestions with respect to their affairs as may be submitted to them. In some of these cases, a successful appeal has been made to the efficient manner in which the party has actually conducted his own affairs.

The proof of imbecility, combined with undue influence, has, in numerous instances, been held to invalidate a will; but, in the absence of such influence, all that is required to establish the wills of people of weak understanding is, that they should have been capable of comprehending their nature and effect.

The question of *responsibility* for crimes, such as arson and murder, can also only be answered by an appeal to all the circumstances of the act, the motives by which it was instigated, and the whole life and character of the accused. This subject of responsibility in criminal cases will be more fully considered when all the forms of unsound mind have been passed in review.

Several interesting and instructive cases of imbeciles concerning whom the two questions of competency and responsibility have been raised,

are given in detail, and made the subject of judicious commentary in Dr. Ray's 'Treatise on the Medical Jurisprudence of Insanity.'

Cretinism.—In many parts of the continent of Europe, especially in valleys lying among hills, but occasionally in unhealthy rural and urban districts in every part of the world, a disease prevails which combines the extreme of bodily deformity and degeneracy with deficiency of intellect. In Switzerland and Savoy persons so afflicted are called cretins, and in France cagots. The morbid feature by which they are chiefly distinguished is the enlargement of the throat, known as goitre or bronchocele; but to this several bodily defects and deformities are superadded. The stature is dwarfed, the belly large, the legs small, the head conical, the arch of the palate high and narrow, the teeth irregular, the mouth large, the lips thick, the complexion sallow, the voice harsh and shrill, the speech thick and indistinct, the eyes squinting, the gait feeble and unsteady, the sexual power weak, or wanting.

The best authorities agree in representing this physical degeneracy, with the coexisting mental deficiency, as commonly dating from a period subsequent to birth. About the fifth or sixth month, the healthy bodily development seems to be checked. The child looks unhealthy and seems weak; the head is large, and the bones widely separated; the belly swells and the limbs shrink; teething goes on very slowly, and the child cannot stand or speak till its fifth or sixth year. Some cases are complicated with spinal distortion, some with hydrocephalus. In rare instances the physical and mental deficiency dates from birth.

It is usual to divide the victims of this singular affection into three classes—cretins, semi-cretins, and the cretinous, or cretins of the third degree. The first class answer to the description of idiocy already given, with the addition of the peculiar deformity of the throat. Their life is automatic; they have no trace of intelligence; their senses are dull, or wholly wanting; they are unable to speak; their time is spent in basking in the sun or sitting by the fire; and nothing but the most urgent calls of nature rouses their attention. They do not possess the power of reproduction.

The next class, or semi-cretins, show a higher degree of intelligence. They may be taught to read and to repeat prayers, but without understanding what they learn; they have no idea of numbers; they note what passes around them, and use language to express their wants; they remember common events, understand what is said to them, and speak intelligibly on common subjects.

Cretins of the third degree show glimpses of a higher nature, and are capable of attaining a certain degree of proficiency in mechanical employments and contrivances, in drawing, painting, and music; but arithmetic is a very rare acquirement. They are said to be acutely alive to their own interest, extremely litigious, unable to manage themselves or their affairs, but obstinate and unwilling to be advised.

Cretins of the second and third degrees, if removed from the place of

their birth and placed under judicious superintendence early in life, are capable of considerable improvement both of body and mind, and may be made useful members of society.

DEMENTIA.

This form of mental unsoundness is to be carefully distinguished from the two forms of *amentia* just described. In idiocy the deficiency is congenital; in imbecility it shows itself in early life; in dementia, on the contrary, it supervenes slowly or suddenly in a mind already fully developed. Dementia differs from mania, on the other hand, inasmuch as the one arises out of the exhaustion and torpor of the faculties, the other from their undue excitement.

The state of the mind in dementia is best described by the word incoherence. There is also a form of mania equally well described by the same word; but the incoherence of dementia is marked by languor, that of mania by excitement. It must, however, be understood that patients suffering from dementia are liable to maniacal paroxysms, and maniacs to remissions of comparatively tranquil incoherence.

Dementia is divided into *acute* and *chronic*, of which the first form is rare, and consists in a condition of profound melancholy or stupor; the second of very common occurrence, and characterized by incoherence.

There are also degrees or stages of dementia, which Prichard indicated by the words forgetfulness, irrationality, incomprehension, and inappetency. A patient suffering from dementia, and passing from bad to worse, would first exhibit want of memory, then loss of reasoning power, then inability to comprehend, and, lastly, an abolition of the common instincts and of volition.

Dementia may occur at any period of life after the development of the mental faculties—in childhood, manhood, or old age. When it occurs in aged persons it is known as *senile dementia.*

The characters of dementia differ with its cause and mode of commencement. That form of it which arises from sudden mental shocks often presents a distinct and very peculiar feature.—The mind is, as it were, arrested and fixed for the remainder of life in sad abstraction on the one event which had occasioned it. In other instances, the shock destroys the power of the mind, and reduces it to a state of imbecility or idiocy.

During the earthquake panic of 1843, the author had an opportunity of seeing a case of dementia in a lad of twelve years of age, brought on by the conversation of a knot of Irishmen in the dusk of the evening, concerning the expected visitation. The poor boy seemed deprived of all his faculties, was dull and listless, and answered every inquiry by a vacant smile. He occasionally had an access of terror and excitement, but soon relapsed into his state of stupor.

The prolonged action of apprehension or grief is another cause of dementia. Dementia also follows upon severe attacks of fever, and

upon mania, melancholia, apoplexy, paralysis, or repeated attacks of epilepsy. In all these cases it may depend on softening or other chronic disease of the brain.

Senile Dementia, or that which is incidental to persons in advanced age, is the most simple and well-marked form of that variety of dementia which arises from causes acting slowly and gradually. The first symptom of approaching senile dementia is loss of the memory of recent events, with dulness of perception and apprehension, and an inability to fix the attention, or to follow any train of thought. The things which were heard five minutes since, are forgotten, and the same question is repeated over and over again. Hence, the transaction of business requiring sustained attention becomes impossible. The power of attention, and the control of the will over the thoughts, becoming more and more enfeebled, the reasoning powers suffer; for scarcely are the premisses laid down before they are forgotten, so that the act of comparison by which the conclusion is arrived at cannot be performed. Hence, after pursuing the same topic of conversation through part of a sentence, some accidental suggestion turns the ideas aside. Persons so affected know their attendants and recognize their friends, but they seldom display signs of emotion on seeing them; and they can still employ themselves mechanically,—men in writing, and women in knitting and sewing. The next phase of the malady is one of complete incomprehension. Memory, reason, and the power of attention are entirely lost; but the muscular force remains intact, and displays itself in perpetual activity, in jumping or running to and fro, or walking round in a circle, or rocking backwards and forwards in a chair, dancing, singing, and shouting, or in talking or muttering incessantly. Many, however, sit silent and tranquil, or with a vacant unmeaning stare, for weeks, months, or even years. A few remain crouched in one uneasy posture, or they stand erect with the neck rigidly fixed at right angles to the body. In the last stage of all, even the animal instincts are lost; there is neither sensation, nor memory, nor thought, nor reason, but bare physical existence; with occasionally, at distant intervals, a short resuscitation of some of the mental powers. Paralysis of the limbs, more or less extensive and complete, is also a common occurrence in this advanced stage of the malady.

Legal Relations of Dementia.—The questions most commonly raised respecting this form of unsoundness of mind relate to the validity of wills made or altered by aged persons alleged to be suffering from senile dementia. The inquiry is generally one of considerable difficulty; inasmuch as patients suffering from senile dementia vary greatly from day to day, and present themselves to different persons in different lights. Accordingly there is room for very conflicting testimony, and wide divergences of opinion, both among unskilled and skilled witnesses; and the legal decision ultimately turns much more on the character of the will itself and its consonancy, or otherwise, with the

known intentions and views of the testator at an earlier period of his life, and with the natural feelings of persons of sound intellect, than on the medical or other evidence respecting his mental condition.

MANIA.

This term includes all those forms of unsoundness of mind which are characterized by undue excitement of the faculties. It differs therefore in a marked manner from those already described, both in its legal relations, and in the tests by which its existence is ascertained. There is no legal term in common use which properly characterizes this state; and one of its most important forms, moral insanity, is as yet unrecognized by the law. The only legal term employed in a sense analogous to that of mania is *lunacy*, which, as has been remarked, is objectionable from being founded on a variable feature of the disease.

Mania is divided in the table at p. 152 into three classes: General, Intellectual, and Moral; and each of these latter into two subdivisions—General and Partial.

General Mania.—There is a form of mania which affects both the intellect and the passions, and throws the whole mind into a state of mingled excitement and confusion. It is the counterpart of the incoherent stage of dementia, and the form which, in some cases, mania assumes from the very first. It would be correctly designated by the phrase "raging incoherence." There is another form of mania which is apt to be confounded with the foregoing variety, on the one hand, and with monomania on the other, but which, when carefully examined, will be found to be a general unsoundness, accompanied with undue excitement of the mind, the predominant feeling or passion merely taking the lead in the unsound, as it had previously done in the sound mind. Both of these forms will be treated under the general term, Mania.

Mania, under whatever form it may appear, except when it is the immediate consequence of injuries, moral shocks, intoxication, poisoning, or acute disease, is preceded by important bodily and mental changes. The period during which these changes are taking place is termed the period of *incubation*, which sometimes embraces a period of fifteen to twenty years. It is described by Georget in terms of which the following is an abbreviation :—

Sometimes the cause acts strongly and rapidly; at other times, slowly and with less force. In the first case, madness breaks out at the end of some hours or days after a state of anxiety and uneasiness, with headache, sleeplessness, excitement, or depression. The patient begins to babble, cry, and sing, becomes wild and agitated, and has the appearance of a person in a state of intoxication. In the second case, the mind is affected gradually and often very slowly. The patient is generally conscious of some disorder in his intellectual faculties; he is

beset by new and odd notions, and by unusual inclinations; he feels himself changing in his affections; but, at the same time, he preserves a consciousness of his condition, is vexed at it, and tries to conceal it; he continues his occupations as much as he can; and like a man in the first stage of intoxication, he makes every effort to appear reasonable. Meantime his health gives way. He either sleeps less or not at all; his appetite is impaired or lost; he suffers from indigestion and constipation; he grows thin, and the features alter. (In females the monthly discharge becomes irregular and scanty, and at last is altogether suspended.) At the same time a great change takes place in the tastes, habits, affections, and character of the patient, and in his aptitude for business; if he was gay, communicative, and social, he becomes sad, morose, and averse to society; if he was open and candid, he becomes suspicious and jealous; if he was moderate in his political and religious opinions, he passes to an extreme exaggeration in both; if he was affectionately attached to wife, children, or relations, he regards them with indifference or dislike; tears and laughter succeed each other without apparent cause; if he was orderly and economical, he becomes confused and prodigal; if he has been correct in his conversation, he indulges in violent and obscene language; if he had long abstained from the pleasures of love, he becomes the victim of insatiable desires, and either seeks to associate with the other sex, or has recourse to disgraceful practices.

If this is the first attack, the persons by whom he is surrounded do not suspect the nature of the ailment which torments him; they put questions to him which lead to no result, except that of fatiguing and giving him pain; or they indulge in offensive insinuations, and charge him with frivolous accusations; and when, at length, he breaks out into furious mania, the attack is attributed to some slight contradiction or some cause equally inadequate to produce it.

When the period of incubation has passed, and the disease is fully established, the mental and physical phenomena undergo a change. The disorder of the cerebral functions assumes a more positive character, the patient believes in the reality of his delusions, and instead of concealing his thoughts, openly and strenuously avows them, except when induced by powerful motives to pursue a contrary course. When thwarted and opposed he makes use of the most violent and insulting language, and often gives utterance to the most obscene expressions. In many cases, too, his violence does not spend itself in words, but he tears his clothes and bedding to pieces, and inflicts bodily injury on himself and those about him. The physical derangement displays itself in febrile excitement, an accelerated pulse, and a wild and sparkling eye, pain, weight and giddiness in the head, ringing in the ears, and restlessness and sleeplessness. The patient is also singularly insensible to cold and heat, and he either abstains from food and drink for long intervals of time, or eats voraciously. The muscular power is inordinately developed, and the patient sustains for a long time, without sleep, a

succession of efforts which would soon utterly exhaust a healthy person. The habits of the patient are often most disgusting and offensive.

General Intellectual Mania.—The opinion is gaining ground that mania is in all cases primarily an emotional disease, and that the affection of the intellect is only secondary. But there is certainly a class of cases in which the disease appears to be almost limited to the intellectual faculties, which are in a highly excited state, while the moral faculties are little if at all affected. But it would probably be more correct to say that, in certain cases, some strong emotion or passion, such as pride, vanity, or ambition, displays itself chiefly by its effect upon the intellect. Thus Dr. Reid, in his work on Insanity, tells us of a vain young medical student, who, in the expectation of realizing a fortune by attaining academical honours, entered himself at Cambridge, and so injured his health by fruitless application to study, as at length to fall into a state of decided derangement. This young man stated that he was the Farnese Hercules; that he had written Dr. Clarke's Travels in Russia; that he had composed the Æneid of Virgil; had painted one of the masterpieces of Raffaelle; and that he knew everything.

Dr. Henry Johnson, in his work on the arrangement and nomenclature of Mental Disorders, also gives the highly characteristic letter of an ambitious patient who contrived to confer upon himself the somewhat incongruous titles of champion and king of England, and heir presumptive to the crown, and at the same time to monopolize all the principal offices of state.

A highly instructive autobiography of a gentleman who had recovered from an attack of mania, shows how general was the disturbance of the whole intellectual and moral being, though the predominant emotion was of a religious character, and it would have been quite possible to describe the case as one of religious monomania.

General intellectual mania is, therefore, in very many cases, to be regarded as the violent disturbance of all the intellectual faculties brought about by the over-excitement of some leading emotion or passion.

Partial Intellectual Mania.—This was formerly called melancholia, from the mistaken notion that such partial affections of the intellect are always of a gloomy character. Esquirol showed that this view of the case was incorrect, inasmuch as the ideas of such persons are not always gloomy, but, on the contrary, oftentimes extremely gay and pleasant; and he substituted the term monomania, which is now generally received.

The most simple form of this disorder is that in which the patient takes up some single notion opposed to common sense, and personal experience; such as, that he is secretary to the moon, the Crystal Palace, a grain of wheat, a goose-pie, a pitcher of oil, a wolf, a dog, or a cat.

In many cases, this single delusive idea relates to, or is occasioned

by, some bodily sensation or disease, which the monomaniac, like the dreamer, associates with imaginary accompaniments, and interprets by the aid of his delusion. Thus, Esquirol tells us of a woman suffering from hydatids in the womb, who insisted that she was pregnant with the devil; of another, who having adhesions of the intestines from chronic peritonitis, imagined that a regiment of soldiers lay concealed in her belly, and that she could feel them struggling and fighting with each other; and of a third, who, suffering from the same morbid condition, believed that the apostles and evangelists had taken up their abode in her bowels, and were occasionally visited by the pope and the patriarchs of the Old Testament.

But such delusions as these, though perhaps originally founded upon real sensations, may continue after the sensations themselves have passed away, as is proved by the cures that have been effected by a very laudable species of deception. Thus, a patient, after thinking himself cured of a serpent in his bowels by means of a pretended surgical operation, suddenly took up the idea, that the creature had left its ova behind, ready to be hatched into a brood of young ones; but was reassured by the dexterous reply, that the snake was a male.

It must not be supposed that such cases of partial intellectual mania comprise all the cases designated as *monomania*. In most instances the affection of the mind doubtless goes beyond a single insane idea, and influences more or less extensively the thoughts and the conduct, being marked by other intellectual and moral inconsistencies: and there is reason to believe, that many cases of so-called monomania are examples of general mania, characterized by the immoderate activity of some one faculty.

Moral Mania.—It was Pinel who first directed the attention of the profession to moral insanity. Previous to his time, insanity was generally considered as either exclusively, or chiefly, a malady of the reasoning faculties. Participating in the common belief of the sufficiency of a few faculties to explain all the phenomena of the sound and unsound mind, and doubtless influenced by the prevalent metaphysical doctrines of his time, he found, to his great surprise, that there were at the Bicêtre many maniacs "who betrayed no lesion whatever of the understanding, but were under the dominion of instinctive and abstract fury, as if the affective faculties alone had sustained injury." He called this form of mental disorder *manie sans délire*. Since his time the reality and great importance of this distinction between intellectual and moral mania have been recognized by practical observers, amongst whom are to be found the well-known names of Esquirol, Georget, Gall, Rush, Keil, Heinroth, Hoffbauer, Cox, Andrew Combe, Abercrombie, Conolly, Prichard, and Ray. Prichard, who has treated this subject with great ability, and has clearly made out that moral generally precedes intellectual insanity, defines moral mania as "consisting in a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions,

without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucination."

Moral mania, like intellectual mania, admits of being distinguished *as general* and *partial.*

General Moral Mania.—Pritchard observes that there are many individuals living at large in society, who are reputed persons of a singular, wayward, and eccentric character. An attentive observer will often recognize something remarkable in their manners and habits, which may lead him to entertain doubts as to their sanity; and on inquiry his suspicions are often strengthened by finding that an hereditary tendency to madness has existed in the family, that several of the relations have laboured under other diseases of the brain, or that the individual himself, in a former period of his life, has had a decided attack of madness. His temper and disposition are found to have undergone a change; to be not what they were previously to a certain time; he has become an altered man, and the difference has perhaps been noted from the period when he sustained some reverse of fortune, which deeply affected him, or the loss of some beloved relative, or some severe shock to his constitution,—some febrile or inflammatory disorder affecting the brain, a slight attack of paralysis, or a fit of epilepsy. In some cases, the alteration in temper and habits has been gradual and imperceptible, and seems to have consisted only in an exaltation or increase of peculiarities which were always more or less natural and habitual. Persons labouring under this disorder are capable of reasoning, or supporting an argument, upon any subject within their sphere of knowledge, and they often display great ingenuity in giving reasons for the eccentricities of their conduct, and in accounting for and justifying their existing state of moral feeling. In one sense, indeed, their intellectual faculties may be termed unsound; they think and act under the influence of strongly-excited feelings, and persons accounted sane are under such circumstances proverbially liable to error both in judgment and conduct.

Hoffbauer, who has written very ably on the subject of insanity, recognizes this form of mental unsoundness.

"It is clear," he says, "that mania may exist uncomplicated with mental delusion; it is, in fact, only a kind of mental exaltation (*tollheit*), a state in which the reason has lost its empire over the passions and the actions by which they are manifested, to such a degree, that the individual can neither repress the former, nor abstain from the latter. It does not follow that he may not be in possession of his senses, and even of his usual intelligence, since, in order to resist the impulses of the passions, it is not sufficient that the reason should impart its counsels,—we must have the necessary power to obey them. The maniac may judge correctly of his actions without being in a condition to repress his passions, and to abstain from the acts of violence to which they impel him." He subsequently observes, that when mania proceeds from inordinate passions, "its more immediate cause

lies in the physical temperament, or in certain moral affections which induce frequent occasions of anger. In every other respect, the maniac may be master of his propensities, and the actions to which they lead; he may judge and act rationally. He is irrational only in his paroxysms of fury, and then his errors of judgment are rather the effect than the cause of his furious transports."

This form of mental unsoundness is illustrated in the works of Pritchard and Ray, by a large number of cases, which may be consulted with advantage. Of these, the most remarkable is that of Frederick William of Prussia, father of Frederick the Great, a drinking and smoking hypochondriac, and the strange, wayward, and cruel tyrant of his family and household. His religious austerities, his disgusting and brutal behaviour to his children, his unfounded hatred of his own son, and repeated attempts upon his life, his solitary attempt upon his own life, his course of steady and unswerving persecution of the innocent objects of his suspicion and dislike, without any delusion beyond that which might fairly be regarded as the offspring of his hate—present a striking picture of general moral mania.

Partial Moral Mania.—This consists in an exorbitant activity of some one passion or propensity, and its predominance or complete mastery over every other. The persons thus affected are generally perfectly conscious of their condition, and they either evince the utmost horror at the enormity of the conduct to which their ruling passion would impel them, and with difficulty restrain themselves, or they give way, as if in desperation, to the impulse which urges them on.

There is not one of the stronger impulses of our nature that may not be thus placed, by morbid excitement, beyond the restraint of reason and conscience. The following varieties are now generally recognized, and described under distinct names:—Kleptomania, Erotomania, Pyromania, Dipsomania, Suicidal Mania, Homicidal Mania. In addition to these forms of partial moral mania, which are of special interest to the public and the legislature, there are many other distinct varieties, some marked by extreme depression, and others by great excitement, which have been classed under the two heads of *Melancholia* and *Exaltation*, of which the first comprises the three species, hypochondriasis, nostalgia, and religious despair; and the second excessive pride, vanity, or ambition.

Cleptomania, or *propensity to theft.*—This form of partial moral mania is of very common occurrence in persons of both sexes, placed by their wealth beyond the reach of vulgar temptation. It is more common in women than in men. A propensity to theft is also a common feature of imbecility and of mania, and has been known to accompany maniacal paroxysms. Pritchard mentions the curious case of a lunatic who would never eat his food unless he had previously stolen it.

Erotomania, or *amorous madness.*—This disease is otherwise known as *Satyriasis* when it attacks men, and *Nymphomania* when it occurs in women. It sometimes attacks virtuous females, who view their excited passions with horror and remorse.

Pyromania, or *propensity to incendiarism.*—This propensity, in common with Kleptomania, is more common in women than in men. It occurs most frequently in young women subject to menstrual suppression or disturbance, and in imbeciles of the other sex.

Dipsomania.—A propensity to excessive indulgence in spirituous liquors is a well-recognized form of unsoundness of mind. In some persons the desire for drink is continuous; in others intermittent. In some the desire is but part of a more general unsoundness; in others it is the true source of all the manifestations of unsoundness which the patient makes. In other words, he is perfectly rational when not under the influence of drink.

Suicidal Monomania.—Much difference of opinion has existed as to the real state of mind of self-murderers. The fact of suicide having been generally practised and sanctioned by philosophers and lawgivers of past times, and of its still being in common use in nations which have attained in many respects a high civilization, such as China and Japan, has led some to the belief that it is not always the result of an insane impulse. The calm and deliberate manner in which the crime is often perpetrated, and the apparent soundness of the reasons alleged in its favour, have been somewhat strangely used as arguments against the opinion of those who attribute suicide in all cases to insanity. A better reason for believing it to be, occasionally at least, altogether independent of insanity is, that in France two persons often combine for the purpose of self-destruction; such union of purpose being extremely rare in the case of the insane.

The argument drawn from national usage in ancient and modern times cannot be allowed much weight, for who would hesitate to characterize an English widow who should burn herself on the death of her husband, as insane? and yet such self-sacrifice was until recently both a virtue and a custom in India. Some savage nations, again, eat human flesh; but in a case of infanticide which occurred in France, the fact that the mother cooked a portion of her child, and ate of it, and then offered the dish to her husband, was justly regarded as a strong evidence of insanity.

A careful consideration of recorded cases of suicide cannot but lead to the conclusion, that a considerable number are the result of insane impulse; and this conclusion is strengthened by the frequent attempts at self-destruction made by the acknowledgedly insane. The extraordinary modes of death sometimes selected might also be urged as an additional argument in favour of the insane origin of suicide. It may be added, that some of our highest authorities, as Foderé and Esquirol, have strongly maintained the necessary dependence of suicide on insanity.

Homicidal Mania.—The most distinguished authors, both at home and abroad, have recognized this form of mental unsoundness, as having an existence independent of delusion. The cases on record are now very numerous, and comprise instances of successful resistance to the impulse in some instances, of voluntary submission to restraint in others, and examples of failure in a third class.

Women seem to have been more frequently than men the victims of this propensity to destroy, and sometimes this excited feeling has led to the commission of infanticide (see p. 111). Females suffering from grief, or anxiety, from habitual discharges, at the menstrual period, at the change of life, and soon after delivery, are thrown into a peculiar nervous state, known as *mimosis inquieta*, which is sometimes accompanied by a strong impulse to crime, with an overwhelming fear of giving way to it. Cases of this kind frequently present themselves among the out-patients of our hospitals.

Melancholia.—There are, as has just been stated, three principal forms of melancholia, all of which are characterized by profound sadness. The first, *hypochondriasis*, consists in a melancholy and desponding view of the condition of the body and of the health, often, but not always, based upon uneasy bodily sensations and disorders of the organs of digestion: the second, *nostalgia*, consists in an intense longing for country and home in those who are exiled: the third, *religious despair.*

Exaltation.—This is a state of mind the opposite of melancholia, which prevails in those who exult in the belief that they are possessed of great personal attraction, great power, great dignity, great inventive faculties, or great projects of benevolence.

It would also be quite possible to select cases from all large collections of insane persons, which would warrant the use of a larger vocabulary of terms—cases, for instance, in which a lying or begging propensity is quite as clearly marked as a thieving propensity in those designated as Cleptomaniacs. Nor is it possible to omit the remarkable cases of *lycanthrophy* which are on record, and one of which (that of the soldier Bertrand) has, within a few years of this time, occurred in France. In this instance, the violation of the grave was an intermittent insane passion, which no sense of personal danger was allowed to disappoint.

Of Mania with Lucid intervals.—Mania, in a considerable number of cases, assumes a recurrent or intermittent form, the patient in the interval being in his right mind. The proportion which such cases bear to those of complete recovery has been variously stated at from one in six to one in ten. The interval is various. Esquirol has seen cases assume the quotidian, tertian, and quartan type ; or the interval has been that of a month, or it has recurred with the same season of the year. More frequently the attacks occur at uncertain intervals, and are of uncertain duration. This recurrent mania, with intervals of complete sanity, must not be confounded with those periods of

comparative tranquillity which, like lulls in a storm, occur in most cases of mania. With regard to such intervals of comparative repose, Haslam remarks that, "as a constant observer of this disease for more than twenty-five years, he cannot affirm that the lunatics, with whom he had daily intercourse, have manifested alternations of insanity and reason. They may at intervals become more tranquil, and less disposed to obtrude their distempered fancies into notice. For a time their minds may be less active, and the succession of their thoughts consequently more deliberate; they may endeavour to effect some desirable purpose, and artfully conceal their real opinions; but they have not abandoned or renounced their distempered notions."

The legal relations of mania with lucid intervals are important. The law generally views civil acts done in lucid intervals as if they were performed by a person in a permanently sound state of mind; it admits the validity of wills made during such intervals, and has on more than one occasion admitted the reasonableness of the will as proof of a lucid interval. With regard to criminal acts, it makes a reasonable distinction; for it justly regards the condition of unsoundness as one readily reproduced by provocation or excitement. The legal relations of the other forms of mania will be considered in the following division.

4. OF SOME OF THE MORE IMPORTANT CHARACTERS OF THE UNSOUND MIND, AND OF THE LEGAL AND MEDICAL TESTS OF THAT UNSOUNDNESS.

A knowledge of the individual characters of mental unsoundness is of the first importance both to the lawyer and to the physician. Without a résumé of its characteristics, a mere description of its several forms would present but an imperfect view of the subject. It is proposed, therefore, to establish, by appeal to facts, some of the more remarkable phenomena of mental unsoundness, as a preliminary to the discussion of the chief legal questions which arise out of that state, and to prescribe, for the guidance of the medical witness, such rules as these phenomena shall be found to suggest for recognizing it, and for distinguishing it from its counterfeit.

Of the Characters of Unsoundness of Mind from Defective Development or Diminished Activity of the Faculties.

There is a simplicity about this division of the subject which does not belong to the other, and the principal characters are more easily deduced from the foregoing descriptions. The law, in reference to this form of unsoundness, moreover, is more simple and more in accordance with medical experience; and its decisions have been more uniform.

The appearance of the idiot or imbecile is in itself almost decisive, and scarcely requires confirmation from an actual inquiry into his mental condition. Difficulty of arousing and fixing the attention; slowness and weakness of comprehension; forgetfulness of recent occurrences; ignorance of social relations; unconsciousness of familiar things, even of such as immediately concern a man's self, as his age, the place in which he lives, and the mode in which he passes his time, the year, the month, and date of the month; ignorance of those public persons and events which are the most frequent topics of conversation, and most familiar to those who take an interest in the common affairs of life, as the name of the reigning monarch, of the prime minister, &c.; a scanty knowledge of arithmetic and of the value of money; an imperfect knowledge of right and wrong, and of the state of the law in regard to the most common and familiar crimes;—may be mentioned among the characters of the several forms of unsoundness from defective development.

In ordinary and extreme cases of imbecility there can be no difficulty in forming a decision as to the competency of the individual to take care of himself and his affairs, to form contracts, to devise property, &c.; but where the imbecility exists in a less degree, the question is by no means of this simple nature, and cases have occurred in which there has been room for much difference of opinion. In this class of cases it generally happens that the individual in question has for some part of his life been at liberty, and entrusted with the management of his affairs. Hence an invaluable test is provided in a comparison of his existing with his former state of mind. This simple and obvious test seems to have been strangely overlooked by medical men, till the interesting case of Mr. Edward Davies gave Dr. Gooch the opportunity of pointing it out, and insisting upon its importance. (See 'Quarterly Review,' 1830, and the first edition of this work.)

The tests of capacity usually recommended in the case of imbeciles are obviously insufficient to determine whether or not a man is capable of managing his own property. The arithmetical test, on which authors have laid so much stress, is merely a test of knowledge, not of power. A man may be the best accountant in the world, but he may labour under a moral imbecility, and have so mean a sense of right, so childish a fancy, and so weak a will, that from infancy to age he may yield to every impulse, and gratify every whim without once counting the cost. In a case that lately came under the author's notice, the individual owed pence as a child, and pounds as a boy, and added debt to debt with each year that passed over his head, till at length a severe disappointment brought on a distinct attack of mania, of which a benevolent but extravagant mission, violent outbursts of passion, and fierce hatreds, arrangements to spend a year's income in a week, and the unfounded expectation of an immense fortune on the morrow, were constituent parts. He became the inmate of an asylum,

with delusions enough to furnish a dozen madmen, settling down at last into the conviction that he was the Saviour of mankind, in which conviction he died. In this case, there was the cultivated and refined intellect of a man with more than the weakness of a child; but no test could have served to prove him incapable of managing himself and his affairs, save only the history of his life.

The criminal acts of persons of weak intellect are as strongly marked by folly as their daily words and actions. They have no other characters, and consequently we have no better test. In the case of imbeciles, as in that of maniacs, the law lays down the test of a knowledge of right and wrong. This is as insufficient a test in criminal, as the arithmetical test in civil cases. It is a test of knowledge, and not of power; and the knowledge of right, and the power to act right, are as distinct as science and art. This subject will be presently examined more at length.

Of the Characters of Unsoundness of Mind from Excessive Activity of the Faculties.

In tracing some of the more prominent characters of this division, or, in other words, of mania, it is proposed to use the term in its most extended sense as applied to those cases (and they are the great majority) in which the intellect, the affections, and the passions, are jointly implicated, whether there be a single delusion or several delusions, or merely some one excited emotion or passion, the source of a thousand changing fancies. This inquiry will prepare the way for an examination of the plea of insanity in criminal cases—a subject of great interest and importance.

1. *In Mania, consciousness, memory, and reason may remain intact, and that even in the midst of the most violent paroxysms.* The opinion, to which reference has just been made, that mania is in all cases primarily an emotional disease is quite consistent with this proposition. It is quite conceivable that the emotions and passions may be under constant or intermittent excitement of the most violent character, and yet that there shall be a perfect consciousness on the part of the patient of all the relations in which he stands towards others, a free use of reason, and a perfect recollection of every occurrence in which he has borne a part. It is true that in the actual paroxysm of maniacal excitement, there may be neither time nor place for acts of comparison or processes of reasoning, and that even conscience may lose all restraining power; but that memory does remain intact, even in the most violent maniacal outbursts, there is no room to doubt. The author was consulted in the case of a lady who had been suffering from mania for a long term of years, and who was subject to paroxysms of extreme violence. In one of these paroxysms she had destroyed some valuable papers belonging to her husband; and yet after the lapse of twenty years, during an interval of tranquillity, she

reverted to the occurrence, and expressed her regret at what had happened. Similar evidence of accurate recollection is to be found in the autobiographies and *vivâ-voce* histories of persons who have recovered from mania.

Of the intact condition of the higher faculties of the mind in the maniac's more tranquil moments no medical evidence need be adduced. It will suffice to quote the words of Mr. (afterwards Lord) Erskine, used at the trial of Hadfield for shooting at George III. in Drury Lane Theatre, in 1800. "In all the cases," he says, "which have filled Westminster Hall with the most complicated considerations, the lunatics, and other insane persons who have been the subjects of them, have not only had memory *in my sense of the expression*,—they have not only had the most perfect knowledge and recollection of all the relations they stood in towards others, and of the acts and circumstances of their lives, but have, in general, been remarkable for subtlety and acuteness. Defects in their reasonings have seldom been traceable,—the disease consisting in the delusive sources of thought,—all their deductions, within the scope of their malady, being founded on the *immoveable* assumptions of matters as *realities*, either without any foundation whatever, or so distorted and disfigured by fancy, as to be nearly the same thing as their creation."

The madman, then, reasons like other men, with this difference, that his delusions being stronger than the imaginations of a sane man, and his passions more violent, reason is more readily made the advocate of the one and the slave of the other. The same observations which apply to the reason apply to the other faculties of the mind. The senses are most apt to rebel; but even they are unsuccessful in their revolt. The delusion is too strong even for them.

2. *The senses are deceived and confounded.* The author of the interesting autobiography referred to at p. 153, says: "My senses were all mocked at and deceived. In reading, my eyes saw words on the paper, which, when I looked again, were not. The forms of those around me, and their features, changed even as I looked on them." "I heard the voices of invisible agents, and notes so divine, so pure, so holy, that they alone, perhaps, might recompense me for many sufferings. My sense of feeling was not the same; my smell, my taste, gone or confounded." The conversion of familiar sounds, such as the lowing of cattle, the falling of water, the grating of a chain, the noise of footsteps, &c., into articulate speech, is not the least remarkable feature of this disorder of the mind. It is scarcely necessary to add, that illusions of sight and hearing are almost universal accompaniments of mania.

3. *The persons with whom the madman associates derive their characters from his delusion.* In the eyes of the author of the autobiography the inmates of the asylum and his keepers were supernatural beings. There was a maniac there whom his spirits called the Lord Jehovah, supremely omnipotent, the Trinity in unity; and one of the

keepers was supposed by him to be the Saviour of mankind. At other times these same persons assumed other shapes, and according to the state of his mind, were either fiends or angels. His delusion could give to any object any shape it pleased.

4. *Real impressions on the organs of sense become, as in dreams, the materials of imaginary scenes.* This curious phenomenon, also, is strikingly illustrated in this autobiography. When the cold air blows upon the patient as he is trying to suffocate himself, in obedience to the spirits which speak within him, he imagines the spirits of his sisters to be breathing on him to cool him and encourage him to go through with his task. The familiar sensation of water trickling down the back is converted into the crystal tears of his father, whose venerable countenance he sees bending over him. His shaven head suggests the painful notion that he has received the tonsure of the Roman Catholic priesthood, a mark of the beast. The jets of gas in the fire become the utterance of his father's spirit, continually striving within him to save him, and continually obliged to return to be purified in hell-fire, in consequence of the contamination it received from his foul thoughts. The lowing of the cattle conveys to him articulate sounds and sentences, and the grating of the chair against the wall speaks to him in his father's voice.

5. *The strange antics of the madman are the effects of his delusion.* The following passages from the autobiography fully establish this proposition: "I expected to be guided to prayer; but a spirit guided me, and placed me in a chair, in a constrained position, with my head turned to look at the clock, the hand of which I saw proceeding to the first quarter; I understood I was to leave the position when it came to the quarter." "Another delusion I laboured under was, that I should keep my head and heart together, and so serve the Lord, by throwing myself head over heels over every stile or gate I came to; the condition here was, as before, on its being done in *precision and decision.*" On one occasion a keeper, in struggling with a patient, throws him down and nearly strangles him. "When I saw his bloated and inflamed cheeks, and the eyes starting out of the sockets, I offered to do anything to rescue him. My spirits desired me to whirl myself round and round as fast as I could, which I did till I staggered against the wall, and nearly fell on the stone pavement." This last quotation suggests the corollary that

6. *The acts of the madman, the results of his delusions, are often such as no sane man would believe fitted to compass the object in view.*

7. *The violence of the madman is often the effect not of mere passion but of his delusions.* "I knew no malice," says the author of the autobiography, "no vice. I imagined that they (the keepers) loved me, and were all deeply interested in the salvation of my soul, and I imagined, too, that I loved them dearly. Yet I wrestled with the keepers, and offered to do so with others, and struck many hard

blows; sometimes, as one informed me, making it difficult for three strong men to control me; yet whenever I did this, I was commanded, that they wished me to do so, to prove my faith and courage, but that they were commanded to prove both till they were satisfied of my sincerity." "It was always a great delight to me to get my hand at liberty, even for a moment, and the first use I usually made of it was to strike the keeper who untied me; directed by my spirits to do so, as the return he desired above all things else, because he knew I was proving my gratitude to the Lord Jehovah at the risk of being struck myself." Doubtless the keepers regarded this as mere senseless and motiveless violence. Do we not equally misunderstand the criminal acts of the lunatic?*

8. *The Maniac, if naturally of a reserved disposition, or when impelled by a strong motive, has the power to conceal his delusion.* The proof of this proposition may be found in every work on insanity; and a remarkable illustration of it was given by Erskine in his defence of Hadfield. A person who had been confined in a lunatic asylum prosecuted his brother and the keeper of the asylum for imprisonment and false duress: Erskine was informed that the man was undoubtedly insane; but he was not told of the particular form which the malady assumed. The prosecutor, himself a witness in support of the indictment, was put into the witness-box and examined; and when Erskine came to cross-examine him, he found his evidence clear, distinct, collected, and rational. He tried to discover some lurking alienation of mind; but during a cross-examination, conducted with all the skill and sagacity of which he was master, for nearly an hour, he was completely foiled: the answers were perfectly rational—there was not the slightest appearance of mental alienation. A gentleman, however, who had been accidentally detained, came into court, and whispered in Erskine's ear that the witness thought he was the Saviour of mankind. On receiving the hint, Erskine made a low bow to the witness, addressed him in terms of great reverence, respectfully begged to apologize for the unceremonious manner in which he had treated a person of his sacred character, and called him by the name of Christ. The man immediately said, "Thou hast spoken truly: I am the Christ!" Pinel relates a similar case. A commission appointed to visit the prison of the Bicêtre, examined one particular patient repeatedly upon many successive days; but all their endeavours to prove the man insane failed. They accordingly ordered a certificate to be prepared for his liberation. It was necessary, before the man was released, that he should himself sign the certificate. It was placed before him, and he signed "Jesus Christ." In a case to which the author has already referred, he has reason to believe that more than one of the patient's delusions was never mentioned to any one but himself, and that only

* These statements, like others in this instructive autobiography, are singularly in keeping with those of a recovered religious maniac who was for a long period under the author's observation.

once; nor could he be induced by long conversations framed for the purpose to give the slightest indication of them to third parties.

9. *The acts of the Maniac often evince the same forethought and preparation as those of the sane.* This fact is well illustrated by the following case: A patient who was confined in the Manchester Lunatic Asylum, had been cruelly treated, and in revenge killed the person who had charge of him. He related, with great calmness and self-possession, the particulars of the transaction to Dr. Haslam. He said: "The man whom I stabbed richly deserved it. He behaved to me with great violence and cruelty; he degraded my nature as a human being; he tied me down, handcuffed me, and confined my hands much higher than my head, with a leathern thong; he stretched me on the bed of torture; after some days he released me. I gave him warning; for I told his wife I would have justice of him. On her communicating this to him, he came to me in a furious passion, threw me down, dragged me through the court-yard, thumped me on my breast, and confined me in a dark and damp cell. Not liking this situation, I was induced to play the hypocrite. I pretended extreme sorrow for having threatened him, and, by an affectation of repentance, prevailed on him to release me. For several days I paid him great attention, and lent him every assistance. He seemed much pleased with the flattery, and became very friendly in his behaviour towards me. Going one day into the kitchen, where his wife was busied, I saw a knife; this was too great a temptation to be resisted: I concealed it about my person, and carried it with me. For some time afterwards, the same friendly intercourse was maintained between us; but, as he was one day unlocking his garden door, I seized the opportunity, and plunged the knife up to the hilt in his back."

10. *The Maniac, in spite of his proverbial cunning, is easily imposed upon.* This characteristic forms the great safeguard of the sane in their dealings with maniacs. A good illustration of it is contained in Lockhart's 'Life of Sir Walter Scott.' Henry Weber, Scott's protégé and amanuensis, had been reproved by him for indulging in habits of intoxication, which injured his health and interfered with his literary pursuits. On the evening after his return from Edinburgh, the author observed Weber's eye fixed upon him with an unusual solemnity of expression. On inquiring after his health, Weber rose and said: "Mr. Scott, you have long insulted me, and I can bear it no longer. I have brought a pair of pistols with me, and must insist on your taking one of them instantly;" and with that he produced the weapons, which had been deposited under his chair, and laid one of them on Scott's manuscript. "You are mistaken, I think," said Scott, "in your way of setting about this affair—but no matter. It can, however, be no part of your object to annoy Mrs. Scott and the children; therefore, if you please, we will put the pistols into the drawer till after dinner, and then arrange to go out together like gentlemen." Weber answered with equal coolness, "I believe that will be better,"

and laid the second pistol also on the table. Scott locked them both in his desk, and said: "I am glad you have felt the propriety of what I suggested—let me only request further that nothing may occur while we are at dinner to give my wife any suspicion of what has been passing." Weber again assented, and Scott withdrew to his dressing-room, from which he immediately despatched a message to one of Weber's intimate companions. The maniac was secured and placed in confinement.

11. *Maniacs in confinement are often conscious of their state, and know the legal relations in which it places them.* An intriguing, unruly, vicious madman was detected with a piece of iron, which he had contrived to shape like a dagger, and fix into a handle. When the weapon was taken away from him, he became excessively abusive, and had to be placed under restraint. In the fit of fury which followed, he uttered the most revolting imprecations, and exclaimed to the keeper, "*I'll murder you yet: I am a madman, and they cannot hang me for it.*" When Martin set fire to York Minster, the inmates of a neighbouring madhouse discussed the question whether Martin would suffer the extreme penalty of the law. Various opinions were expressed; but in the midst of the conversation, one patient, apparently as mad as the rest, exclaimed, "He (Martin) will not be hanged — of course he will escape." "For what reason?" asked several voices. "They cannot hang him," replied the lunatic, "because he is mad,—*he is one of ourselves!*"* It is important to understand that this consciousness of their state occurs only in the case of madmen surrounded by madmen in lunatic asylums, or in the case of those who have been under treatment.

The foregoing are some of the more prominent of those characters of mania which bear on the decision of medico-legal questions. They serve to throw light upon the phenomena of insanity, and to answer some of the arguments advanced by persons ignorant of the real nature of this strange condition of mind.† To those who are better informed, they may be useful by setting forth more clearly than any general description can do, the contradictions of which the madman is the sport.

It is probably beyond the power of the sane mind to conceive the confusion which reigns in the mind of the madman. A series of delusions, the offspring of some one excited passion or emotion, or one single delusion, the work of fancy, the interpreter of every sensation, the source of every thought, the mainspring of every action; holding every faculty in stern subjection, making the senses its dupes, the reason its advocate, the fancy its sport, and the will its slave; now whispering in the ear things unspoken, now painting on the eye things unseen; changing human beings at will into fiends or angels; convert-

* Winslow's 'Plea of Insanity in Criminal Cases,' pp. 16, 17.

† For a very able exposition of some of the characters of mania, see Abercrombie, 'On the Intellectual Powers,' 9th edition, pp. 315 and 326.

ing every sensation into a vision, every sound into articulate speech; the unreal world within in constant conflict with the real world without; understood of no one, yet believing himself to be comprehended by all; punished for the very actions which he supposes his tyrants to have commanded, controlled in everything which he thinks it his duty to perform. There is no wish however presumptuous, no fancy however monstrous, no action however absurd, no crime however heinous, that his delusion cannot create, prompt, and justify. That a sane man might form a conception, however faint, of the distraction of such a state as this, it would be necessary to combine into one whole the strange confusion of a dream, and the sleeper's entire belief in its reality, the varying impressions and changing scenes of his waking hours, and the conduct, to him wholly unintelligible, of those about him.

The degree of confusion existing in the mind of the madman will, of course, vary with the nature and extent of his delusions. When several delusions spring from one excited emotion or passion, such as pride, vanity, or religious veneration, the distraction may be expected to be greater than when one single delusion takes possession of the mind. But in this latter case, though the confusion will be less, and there may be many and long intervals of apparent sanity, the patient's mind will be as abject a slave to the one delusion as to the many.

Legal relations of Mania. There is a difference worthy of note between the effect of mania on civil and criminal acts. In civil cases, if a man can be shown "to be *non compos mentis*, the law avoids his act, though it cannot be traced to, or connected with, the morbid imagination which constitutes his disease, and which may be extremely partial in its influence on conduct."* But in criminal cases, it is not enough to prove a man *non compos*: it must be shown that at the time he committed the act he did not know right from wrong. It is not easy to understand the ground of the distinction thus established between civil and criminal acts. If it be just to deprive a man of the management of his property on account of a delusion which has no immediate connexion with the affairs of business, ought not the same delusion which renders him incapable of civil acts, to render him also incapable of crimes? Do not the same faculties concur in civil as in criminal acts? Is there not in both some wish or emotion or passion to originate the act, reason, or instinctive cunning, to plan it, and will to execute it? The civil acts of a maniac are not void on account of the direct effect of his delusion upon them, but because there is no security that the influence of the delusion may not at any moment extend beyond its usual sphere of action. It is just so with his criminal acts. The delusion which ordinarily affects only the intellect, or shows itself in harmless peculiarities of conduct, may lead to

* Erskine, in his defence of Hadfield.

acts of atrocious violence; and it is reasonable to suppose that the mind which is in such an excited or perverted state that it can oppose no effectual check to delusive ideas, is also in such a state as to be able to offer no effectual resistance to a criminal impulse. The importance of this subject will justify a more lengthened examination of it.

The plea of Insanity in criminal cases.—It is necessary to premise that the plea of insanity may be raised in respect of several criminal offences, such as homicide, arson, and theft; but as the large majority of cases in which the plea has been set up have been cases of homicide, and all the legal discussions of importance have arisen out of such cases, the remarks which follow must be understood to relate primarily to them. It ought also to be borne in mind that though the plea of insanity may be set up in reference to homicidal acts committed in a maniacal paroxysm, and by persons otherwise rational alleged to be seized with an uncontrollable impulse, the cases which have been brought under discussion belong to the class of mania with delusion in which the homicidal act has been carefully planned, and carried deliberately into effect.

Our earliest legal authorities evidently confounded mania with idiocy, for Bracton defines a madman as one who "does not understand what he is doing, and, wanting mind and reason, differs little from brutes;" and when the attorney-general, on the trial of Hadfield, in the first year of this century, laid down the law, "that to protect a man from criminal responsibility there must be a *total* deprivation of memory and understanding," Erskine admitted this to be "the very expression used both by Lord Coke and by Lord Hale."

This *total* insanity Lord Hale was the first to distinguish from *partial* insanity, and he first laid down the principle, that partial insanity is no excuse in the commission of any capital offence. The same authority suggests as a measure of responsibility, "that such a person as, labouring under melancholy distempers, hath yet as great understanding as ordinarily a child of fourteen years hath, is such a person as can be guilty of treason and felony."

The practice of our courts of law was for a long time in strict conformity with the principle thus laid down by Lord Hale. Thus, Mr. Justice Tracy, in the trial of Arnold in 1723, for shooting at Lord Onslow, observed: "It is not every kind of frantic humour, or something unaccountable in a man's actions, that points him out to be such a madman as is exempted from punishment: it must be a man that is totally deprived of his understanding and memory, and doth not know what he is doing, no more than an infant, than a brute, or a wild beast: such a one is never the object of punishment."

The trial of Hadfield gave the death-blow to the doctrines of Lord Hale, and established delusion as the true test of intellectual mania. In conducting the defence, Erskine showed that what the law had styled madness was idiocy—the idiocy *à nativitate vel dementia*

naturalis of Lord Hale himself—and that no such madness as that imagined by the older writers had "ever existed in the world." He then succeeded in showing that "delusion, when there is no frenzy or raving madness, is the true character of insanity," but added the very questionable proviso that in order to render the madman irresponsible for crime, it must be shown, that the act in question was the immediate unqualified offspring of the disease.

These new doctrines, though always quoted with approbation, were soon lost sight of, and in place of the test of delusion, sprang up that of "right and wrong." Thus, in the case of Bellingham tried at the Old Bailey for the murder of Mr. Perceval, May 15, 1812, Mansfield, C. J., is reported to have told the jury, that they must be satisfied, in order to acquit, that the prisoner was incapable of judging between right and wrong, and that at the time of committing the atrocious act with which he stood charged, he did not consider that murder was a crime against the laws of *God and Nature*. In a case which occurred only two months later (that of Bowler for shooting Mr. Burrowes), Mr. Justice Le Blanc left it to the jury to determine whether the prisoner, when he committed the offence, was incapable of distinguishing between right and wrong, or whether he was under any illusion in respect to the person he shot, which rendered his mind at the time insensible to the nature of the act he was about to commit; since in that case he would not be legally responsible for his conduct. In a still more recent case (Rex *v.* Offord), Lord Lyndhurst told the jury to acquit, if they were satisfied that the prisoner did not consider his act any crime against the laws of *God and Nature*. A similar principle with slight and unimportant verbal variations was affirmed in the trial of Oxford for firing at the Queen, in the recent case of M'Naughton, in the able exposition of the law by the lord chancellor before the House of Lords, by the law lords who spoke on that occasion, and, lastly, by all the judges to whom this grave question was referred.

There can be no doubt, then, that the legal test at present received is the power of distinguishing right from wrong. But the difficulty of applying this test in practice is so great that judges often, and juries always, prefer a more easy and reasonable mode of procedure. Thus, in the case of Hadfield, Lord Kenyon, with the concurrence of the rest of the judges of the Queen's Bench, interrupted the defence, and said that "with regard to the law, as it had been laid down, there could be no doubt whatever. If a man be in a deranged state of mind at the time of committing an act, he is not criminally answerable; the material part of the case is whether, at the very time, his mind was sane. His insanity must be made out to the satisfaction of a moral man meeting the case with fortitude of mind, and knowing the anxious duty he has to discharge." Here, then, the distinction between right and wrong is altogether lost sight of, and the simple practical question of the insanity of the accused is made to take its place. As

a general rule, however, the theory and practice of the law have been so far consistent, that though the verdict of the jury has been couched in general terms, the test of right and wrong has been distinctly propounded from the bench. In the case of M'Naughton, for instance, the jury brought in a verdict of "not guilty, on the ground of insanity," after Chief Justice Tindal had in his charge strongly and clearly laid down the distinction of right and wrong.

The state of the law up to a recent date, and, indeed, up to the present time, may be inferred from the answers of the fifteen judges to the questions suggested by the trial of M'Naughton. These questions were submitted by the judges to the House of Lords, and the answers, in which the whole bench, with the exception of Mr. Justice Maule, concurred, were read to the house by Lord Chief Justice Tindal on the 19th June, 1843. From these questions and answers given *in extenso* at the foot of this page,* the present state of the law in respect of

* Question I. What is the law respecting alleged crimes committed by persons afflicted with insane delusion, in respect of one or more particular subjects or persons: as, for instance, when at the time of the commission of the alleged crime the accused knew he was acting contrary to law, but did the act complained of with the view, under the influence of some insane delusion, of redressing or avenging some supposed grievance or injury, or of producing some supposed public benefit?- Answer. *The opinion of the judges was, that, notwithstanding the party committed a wrong act, while labouring under the idea that he was redressing a supposed grievance or injury, or under the impression of obtaining some public or private benefit, he was liable to punishment.*

Question II. What are the proper questions to be submitted to the jury, when a person alleged to be affected with insane delusion, respecting one or more particular subjects or persons, is charged with the commission of a crime (murder, for example) and insanity is set up as a defence?—Answer. The jury ought in all cases to be told that every man should be considered of sane mind until the contrary were clearly proved in evidence. That before a plea of insanity should be allowed, undoubted evidence ought to be adduced *that the accused was of diseased mind, and that at the time he committed the act he was not conscious of right and wrong.* This opinion related to every case in which a party was charged with an illegal act, and a plea of insanity was set up. *Every person was supposed to know what the law was, and therefore nothing could justify a wrong act except it was clearly proved that the party did not know right from wrong.* If that was not satisfactorily proved, the accused was liable to punishment; and it was the duty of the judge so to tell the jury when summing up the evidence, accompanied by those remarks and observations which the nature and peculiarities of each case might suggest and require.

Question III. In what terms ought the question to be left to the jury as to the prisoner's state of mind at the time when the act was committed? No answer.

Question IV. If a person, under an insane delusion as to existing facts, commits an offence in consequence thereof, is he hereby excused?—Answer. *If the delusion were only partial, the party accused was equally liable with a person of sane mind. If the accused killed another in self-defence, he would be entitled to an acquittal; but if the crime were committed for any supposed injury, he would then be liable to the punishment awarded by the laws to his crime.*

Question V. Can a medical man, conversant with the disease of insanity, who never saw the prisoner previously to the trial, but who was present during the whole trial and the examination of all the witnesses, be asked his opinion as to the state of the prisoner's mind at the time of the commission of the alleged

These answers are not given verbatim -
See Mayne's Penal Code pp. 45 46.

homicidal acts, committed by persons afflicted with mania accompanied by delusions, may be inferred to be as follows:—That a person who commits an act under the influence of an insane delusion, with a view of avenging some supposed injury, redressing some supposed grievance, or producing some supposed public benefit, is liable to punishment, if, at the time of committing the act, he knows that it is contrary to law; and that if the delusion is only partial, the responsibility incurred is equal to that attaching to a person of sound mind. It further appears that before the plea of insanity can be allowed, it must be proved in evidence that the accused was of diseased mind, and that at the time of committing the act he was not conscious of right and wrong. He is assumed to know what the law is, and is only held irresponsible for his act if his mind can be shown to be so unconscious of right and wrong that he is incapable of appreciating the law and its requirements. This is the only reasonable interpretation which can be given to the doctrine of the judges. "Every person was supposed to know what the law was, and *therefore* nothing could justify a wrong act, except it was clearly proved that the party did not know right from wrong."

Four distinct questions are suggested by this brief summary of the decisions of the fifteen judges. 1. Are the class of maniacs now under consideration (namely, those who commit acts of violence under the influence of delusions, and with premeditation) cognizant of the law? 2. Can they distinguish right from wrong? 3. Do the answers to these questions apply to persons subject to *partial* delusions? 4. Are these legal and moral tests of any practical utility?

1. *Are maniacs, who commit premeditated acts of violence under the influence of delusions, cognizant of the law?* The answer to this question is easy. There is every reason to believe that these persons possess the intelligence and consciousness requisite to the knowledge and appreciation of the law. They have been shown to be as a class by no means wanting in memory, observation, or reasoning power. Some of them have committed murder that they might suffer the penalty of the law; those who, from being placed under restraint, have grown conscious of their infirmity, know or believe that they are by that infirmity rendered irresponsible, and it is in the last degree improbable

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crime, or his opinion whether the prisoner was conscious, at the time of doing the act, that he was acting contrary to law? or whether he was labouring under any, and what delusion at the time?—Answer. The question could not be put in the precise form stated above, for by doing so it would be assumed that the facts had been proved. When the facts were proved and admitted, then the question as one of science would be generally put to a witness under the circumstances stated in the interrogatory.

Mr. Justice Maule dissented from the answer to this last question. In his opinion such questions might be at once put to medical men without reference to the facts proved; and he considered that this had been done, and the legality of the practice thereby confirmed on the trial of M'Naughton.

that monomaniacs whose intellects appear to be so little affected that they are allowed to mingle in society like other men, should be ignorant of a law with which from their earliest years they have been familiar, and of which we are all, unfortunately, too often reminded. The knowledge and consciousness of this law may be fairly expected to be the very last of which madness would deprive a man.

2. *Can they distinguish right from wrong?* There is reason to believe that the class of maniacs now under consideration are conscious of the difference between right and wrong, and if asked whether murder is an offence against law, divine and human, would answer unhesitatingly in the affirmative. But there is equally reason to believe that if a maniac subject to delusions were to conceive the desire to commit murder, he would be as incapable of resisting that desire as he had already proved himself incapable of resisting his delusions. There is a fair and reasonable analogy between the insane thought and the insane wish. His delusions have already defied the evidence of his own senses, the efforts of his own reason, the testimony of his sane neighbours, and the remonstrances of his friends; and his impulses will probably prove as irresistible when confronted with his knowledge of the distinction between right and wrong and the remonstrances of his conscience.

3. *Of partial delusions.* It is natural to suppose that a maniac subject to a great number of delusions would be less able to control his irregular impulses than one who has but one or two delusions. A multitude of delusions naturally implies more confusion and more excitement. A single delusion may be supposed to be more compatible with self-restraint. Single delusions are, however, of rare occurrence, and do not often figure in courts of law. *Partial delusions* are much more common, but when they are closely examined they are found to be the offspring and natural expression of some one excited feeling or passion, which, having had strength enough to create illusions of the senses and delusions of the mind, may be expected to give rise to insane impulses of great power.

The excited feelings or passions which, having first destroyed the integrity of the senses and mental faculties, proceed to instigate acts of violence and cruelty, are religious excitement or despondency, and jealousy. Domestic anxieties exaggerated into fear of starvation, and discontent transformed into an insane belief in persecution, are also fruitful sources of illusions, delusions, and acts of violence. Now the acts of violence which ultimately flow from these excited feelings or passions, after they have given rise to a series of delusive ideas, ought to be judged by the same rules which apply to the delusions themselves. The acts are probably as little subject to restraint as the delusions to correction.

If the four most common sources of homicidal acts—religious excitement or despondency, jealousy, domestic anxiety, and discontent—are submitted to further analysis, the objection to the plea of insanity will be found to be narrowed to a small number of cases.

Maniacs under the influence of religious excitement or despondency are subject to illusions and delusions of a very singular kind. They frequently transform the persons with whom they are associated into supernatural beings, endowed with authority or power not to be questioned or resisted, and they convert common and familiar sounds into the articulate language of temptation or command. One religious maniac, therefore, kills a relative or a keeper, imagining him to be a beast, or a fiend; another has an honest conviction that he is above the law. Perhaps he believes himself to be the Deity, or that he is commissioned by him to fulfil some mission of wrath or extirpation. In cases of religious mania, then, we can never confidently affirm that the criminal act was not the natural consequence of a delusion which placed the maniac, in his own sincere conviction, beyond and above the operation of human laws; or of a command which he would deem it impious to resist.

Of homicidal acts instigated by jealousy shaping itself into a distinct delusion it will suffice to observe that they are such acts as if committed by sane men on the evidence of their senses, would be punished as manslaughter and not as murder.

Of the infanticides committed by fathers and mothers under the pressure of domestic anxiety culminating in an insane dread of starvation, it may be observed that they are the acts of parents generally remarkable for their domestic virtues and devoted attachment to their victims, and that between them and ordinary murderers there is no single point of resemblance.

Discontent, transformed into an insane belief in persecution, presents greater difficulties. The case against the insane believer in persecution is generally put in a form which seems to preclude a satisfactory answer. A maniac believes himself to have been injured by another, and he takes away his life. If the injury were real instead of imaginary, the murderer would be responsible for his act, and so, it is contended, ought the madman to be. This argument would be valid if all the concomitants in the two cases were the same; but, in reality, they have nothing in common but the act itself. The imaginary offence has imaginary accompaniments, and every thought connected with it is one of confusion. The supposition that the mind which can imagine an impossible offence is sound in all other respects is opposed to the strong conviction of all men of experience among the insane. They all with one consent repudiate the notion of a mind subject to such a delusion being sound, and free to act as it will, beyond the sphere of its influence.

The more closely the subject of this partial delusion is observed, the more extensive is found to be the disorder of his intellect. Those actions which are not directly prompted by his delusion are more strange, and his passions are more excitable than those of other men. The theory of a single insane idea springing up in the mind, unaccompanied by any other disordered action of the faculty from which it takes its rise, having no effect upon the remaining faculties, and showing

itself simply by prompting an action, which, when once suggested, is carried out with the complete consciousness of its real nature which exists in the mind of a sane man acting under the suggestion of a corresponding reality, is too absurd to be for one moment entertained. Even in this case, therefore, the question of responsibility cannot be decided by the simple test of a knowledge of right and wrong.

But there is another case allied to the one now under consideration which presents still greater difficulties. A man receives a real injury, and he avenges himself; but it is alleged that he was not of sound mind when he committed the act. The unsoundness of his mind is admitted, but he is deemed responsible as committing murder under the instigation of the common motive of revenge. On the other hand, it is reasonable to allege that the real injury has been by his insane mind magnified to an undue importance, and then acted upon just as if it had been altogether imaginary; that he is therefore neither more nor less responsible for his act than the man whose motive was from the first purely imaginative. In this case, too, an inquiry into the state of mind, extending much beyond the legal test, will be necessary, and cannot be refused; and this very inquiry, once granted, must result in showing the insufficiency of the test. Even in those cases where the criminal act cannot be traced to any delusion of which it is the legitimate offspring, but it is simply alleged in defence that the party is of unsound mind, the very fact of the unsoundness becomes an irresistible plea in mitigation. It would be strange, indeed, if the case of the unhappy maniac under the accusation of crime were the only one in which such a plea is ignored and refused.

4. *Are these legal and moral tests of any practical utility?* If the utility of a test is to be measured by the facility of its application, this test of a knowledge of right or wrong will certainly be condemned. It fails in the hands of the medical witness, it is often practically set aside by our judges, and it is never really applied by our juries, as the very form of their verdict shows. In most cases it is comparatively easy to ascertain the fact of unsoundness of mind, but it is impossible to determine the precise effect of that unconsciousness upon the madman's acts. But it is eminently absurd to credit a mind which is already occupied by delusions with an otherwise efficient state of its faculties. It is in the highest degree improbable that a mind so possessed is able, beyond the sphere of its delusions, to think, feel, and act with the clearness, force, and freedom of the sane.

Some writers, under a strong sense of the failure of the legal test of a knowledge of right and wrong, have sought to set up in its place the power of control or restraint. The test has been thus transferred from the intellect to the will—from the knowledge of right to the power of acting aright. But this is a mere shifting of the difficulty. It is obviously quite as easy to ascertain a man's abstract knowledge of right and wrong, lawful and unlawful, as the exact amount of self-restraint which he possesses.

This test appears to have one advantage over the knowledge of right and wrong. It is thought that the mode of accomplishing the homicidal act will itself throw light on the amount of restraint or self-control which the maniac is able to exert. If he watches his opportunity, bides his time, prepares a fitting instrument, and uses it in the ordinary way, it is inferred that he possessed such an amount of self-control as ought to have prevented the murderous act. The objection to this test is obvious. It is drawn from the analogy of the madman's sensations and thoughts. If he could not prevent the senses from being the sport of illusions, and was unable to root out delusions from his mind, it is not to be supposed that he can control the irregular impulses and passions which are to the will what illusions are to the senses or delusions to the intellect. And if it is alleged that the skill evinced in planning the homicidal act, and the patience shown in waiting for a favourable opportunity, ought to be taken as evidence of adequate self-control, appeal may again be made to analogy. The acts of the maniac are in strict keeping with his thoughts. His delusions, even when they are most distinctly present to his mind, are quite compatible with the exercise of all his faculties. If they are attacked, he defends them acutely and justifies them plausibly. They have not destroyed his faculties, they have merely perverted them to a wrong use. So is it with his homicidal act. The impulse which seizes upon his unsound mind does not destroy his powers, it merely perverts them. Accordingly, if a maniac is under the delusion that his keeper is a fiend, or if he believes that the Deity has commissioned him to take away the keeper's life, he will load a pistol, watch his opportunity, and act in every respect as a sane criminal would do. And, if prevented on one occasion, he will wait for a more favourable opportunity. Nay, the merest imbecile knows that a knife or a pistol is a common instrument of death; and weak as his mind may be, he conceals his weapon, not because he is conscious of guilt, but because he knows that, if it were openly displayed, the action he contemplates would be prevented. The fact is, that in proposing this test, as in the general discussion of this question, two distiuct things have been confounded,—the act itself, which is the result of the delusion, and the mode of accomplishing it. It is the delusion which distinguishes the madman and not the mode in which the delusive impulse is carried into effect. This test, then, is open to the same objections which lie against the legal tests : it seems reasonable, but it is not practical.

The difficulty of devising a test which shall not be open to the most serious objections has led some persons to devise an easy method of escape by depriving persons of unsound mind of what is called the privilege of insanity, or, in other words, refusing to entertain the question of the state of the mind at all. This suggestion may have the merit of simplicity, but it is open to the very serious objection that it could be acted upon only once. The spectacle of a madman on the

scaffold would be simply intolerable. No jury conld be found to convict; and the indiscriminating statute would prove as complete a dead letter as the statute which awards the punishment of flogging to assaults upon the Queen did, when it was to be applied to the person of poor Lieutenant Pate. The idea of hanging and flogging madmen is utterly repulsive, and must be given up.

Another theory entertained by some writers of eminence is, that as madmen are, like other men, influenced by fear, the punishment of death, as the consequence of murder, should be kept before their eyes. This theory may be said to have broken down in the case of Lieutenant Pate, just referred to. It is most probable that this poor imbecile was cognizant of the degrading punishment awarded by a recent statute to persons who should assault the sovereign; but the threat had no effect upon him. By parity of reasoning, it seems most probable that the threatened punishment of death would prove equally ineffectual in every class of madmen. But, in reality, the restraining influence of the punishment of death is already brought to bear upon persons of unsound mind; for it should be borne in mind that men who have not been certified as insane, and confined in lunatic asylums, do not believe themselves to be mad. They are, in their own sight, sane men. It is only after men have been taught, by confinement as madmen, that they are insane, or are believed to be so, that the terror of the gallows is replaced by the alternative terror of perpetual imprisonment.

Those who maintain the theory now under examination are apt to defend it by comparing persons of unsound mind with the lower animals, alleging that, as dogs can be weaned by punishment from practices distasteful to their masters, so madmen can be deterred from crime by fear of death. In putting forward this argument from analogy two facts are overlooked—the fact that the animal has been punished, and has a distinct recollection of the pain inflicted upon him, while the madman has been merely threatened; and the fact that there are many dogs who cannot be weaned from bad habits by the frequent repetition of the most severe chastisement.

In the case, then, of the class of maniacs now under consideration, who, being subject to delusion, commit their acts of violence with premeditation, it is submitted that all the legal and moral tests are inapplicable and useless; and that the law of England ought to be assimilated to that of France—" Il n'y a ni crime ni délit lorsque le prévenu était en état de démence au temps de l'action."

It may be objected that under such a law, unless the most rigid proof of insanity were required, some men would escape who ought to suffer the punishment of death: but, on the other hand, none who did not deserve death would be executed; and it is a generally acknowledged principle, that it is better that many guilty persons should escape than that one innocent man should suffer. Moreover, a verdict of acquittal, on the ground of insanity, brings with it, as a necessary

consequence, confinement for life, which, were it inflicted as a punishment, would hardly be second in severity even to death itself.

Nor is there any good reason to fear that, by exempting the madman from the punishment of death, we shall weaken the hold which the law has on the man of sound mind ; for, in order that he may escape death, he must successfully feign insanity—a task of no ordinary difficulty—and, if he succeed, a perpetual sacrifice of liberty awaits him. It is not likely, therefore, that society will suffer any injury from the adoption of the course here advocated ; and we may perhaps find that it gains something by openly attributing to disease some of the most revolting crimes which degrade and debase our common nature.

In respect to the responsibility of madmen, then, the law seems to be in this dilemma:—it must either insist upon a test which it is impossible to apply, or it must uniformly refuse or admit the plea of insanity. If it hold to a test, its decisions will want that uniformity which ought to belong to them, and their soundness will be constantly liable to be called in question ; if it reject the plea of insanity it ought forthwith to do away with all other pleas in mitigation.

The foregoing observations apply to those cases only in which distinct proof has been obtained of unsoundness of mind, existing previously, as well as at the very time of the criminal act, and not to that instinctive madness which is altogether independent of the intellect, and consists merely in uncontrollable impulse. This form of madness is now generally recognized by medical men, and has on more than one occasion led to the acquittal of an accused party. The criminal acts committed under its influence have most or all of the following characters :—

They are without discoverable motive, or in opposition to all known motives. A man kills his wife to whom he is tenderly attached, a brother his sister, a mother her infant ; or the victim is one whom the madman never saw before in the course of his life, and against whom it is impossible that he can bear any malice. After the commission of the act, he does not seek to escape ; he often publishes what he has done ; does not conceal the body from view, but openly exposes it ; delivers himself up to justice ; describes the state of mind which led to the act, and either remains stupid and indifferent, or is overwhelmed by remorse. He has no accomplices, has made no preparations, and takes nothing from his victim. Sometimes he has previously spoken of his strong temptation, and begged to be prevented from doing mischief.

These homicidal acts are generally preceded by a striking change of conduct and character, and, on inquiry, the accused is often found to have an hereditary tendency to insanity, to have attempted suicide, to have expressed a wish for death, or to be executed as a criminal.

In this class of cases it is most important that all the circumstances should be duly weighed, and that careful search should be made after those motives which most frequently actuate the criminal. It is in

such difficult cases, too, that a caution is especially necessary against basing a decision upon one or two alleged characteristics. All the circumstances of the act ought to be duly weighed, in the spirit of the words of Lord Hale: "lest, on the one side, there be a kind of inhumanity towards the defects of human nature, or, on the other side, too great an indulgence given to great crimes."

This instinctive madness is no doubt sometimes associated with delusion, the criminal act itself being the result of strong excitement of the passions, while the delusion suggests the motive. To this class probably belong those cases of wholesale murder in which the father of a family destroys his wife and children, to prevent them from falling victims to starvation, and then puts an end to his own life: the idea that such an evil threatens them being insane, no less than the impulse which prompts such a mode of escape.

In order to complete this inquiry into the plea of insanity in criminal cases, it would be necessary to enter into minute details respecting the different aspects given to criminal acts by the several varieties of unsound mind. The want of space for so full a discussion of the subject leads me to substitute the following brief summary:—An imbecile has a confused and imperfect notion of crimes, laws, and punishments; and his acts are as foolish as his thoughts. The case referred to at p. 164 is a good example of crimes committed by this class. A monomaniac fancies himself an object of persecution, and he murders one of his imaginary tormentors. His act is as mad as his thought. He destroys one of his supposed enemies, and hopes thereby to rid himself of all. Such was M'Naughton. Another having betrayed decided symptoms of madness, receives a real injury, and murders the person who has injured him. Such was Lord Ferrers. A third, oppressed with melancholy fears, kills those to whom he is most attached, to save them from some imaginary fate. Such was the female already referred to, who, under the fear of starvation arising out of temporary difficulties, murdered her child, cooked it, ate of it, and offered the dish to her husband. Lastly, we have the so-called instinctive madness, of which the case of William Brown, given at length in Ray's 'Medical Jurisprudence of Insanity,' affords a good example.

FEIGNED UNSOUNDNESS OF MIND.

Men feign insanity from the same motives which lead to the simulation of other diseases. Of this class of feigned diseases, too, as of those already noticed at greater length at p. 145, it may be stated that it is only by actual experience of the real disease that the counterfeit can be detected. Indeed, this remark is generally acknowledged to be peculiarly applicable to feigned insanity.

Idiocy.—This form of mental unsoundness is rarely assumed, and, when feigned, is easy of detection. The idiot has almost always a

peculiar form of head, accompanied in most instances by other deformities; and it must always be practicable to learn so much of an impostor's history as that he was not always in the condition which he has assumed.

Imbecility.—In this case, too, the history, where it can be obtained, will assist in unmasking the imposition; and where the previous history is unknown, the patient, by assigning his unsoundness to some inadequate cause, may assist us in our diagnosis. The peculiar cast of countenance of the imbecile is extremely difficult to imitate. The dull, stupid, vacant, and wandering look, corresponding with the unsettled and uneasy manner, the disconnected and evanescent ideas, the variable temper and spirits, the sudden and transient gusts of passion, and the foolish acts utterly unsuited to bring about the objects he professes to have in view, are, collectively, very difficult to assume. In the less strongly-marked forms of real imbecility, folly and acuteness are displayed indifferently on all subjects; but the impostor is shrewd on those which involve his interest or the success of his scheme, and displays his stupidity only in matters of indifference.

This class of cases, however, presents unusual difficulty of diagnosis, and gives rise to great differences of opinion among medical men. Several cases have come under the notice of the author of imbeciles certified as insane by the medical officers of prisons, and returned from the asylums as impostors; and other cases in which, after long and careful observation under the most favourable circumstances, two equally competent observers have not been able to agree in their opinion. Unsettled habits, wandering and disconnected thoughts, sudden bursts of passion, unprovoked acts of violence, unsuccessful attempts at suicide, transient and half-formed delusions, short fits of industry, handywork displaying much skill and ingenuity, make up a combination which it would be in the power of a good actor to assume. But imbeciles of this order possess sufficient shrewdness and self-control to conceal and moderate their eccentricities when they have an object to accomplish. So that it is quite possible for a real imbecile in prison to seem an impostor in an asylum.

Dementia.—This form of unsoundness is rarely imitated. That torpor of all the faculties which belongs to the true disease is not readily put on and sustained; and we shall be much assisted in our diagnosis by bearing in mind the fact that dementia, where it is not the result of a sudden and severe mental shock, is the consequence of a disease of the brain, which, sooner or later, reveals itself in paralysis.

Mania.—As it is more easy to assume the violence of mania than the more subdued characters of the foregoing forms of unsoundness, mania is more frequently feigned. The distinction between the fictitious and the true disease, though occasionally requiring time and continued observation, is not difficult; but in this, as in other feigned diseases, the impostor often obstinately resists the efforts of the medical man to obtain a confession of his fraud.

The peculiar intense expression of the countenance, the marked alteration of the features, and the wildness of the eye, which belong to real mania, can scarcely be successfully assumed. The vehement excitement, the loud shouts, the strong struggles, and violent convulsive movements of the paroxysms also scarcely admit of imitation, and cannot be supported for any length of time.

The real maniac will continue without sleep for days, and even weeks, or, if he sleep at all, his rest will be disturbed and agitated; but the impostor can scarcely keep himself awake beyond one or two days, and a dose of opium, which would produce no effect whatever upon the madman, would infallibly send the impostor to sleep. The same remark applies to other remedies, such as emetics and purgatives. The madman will also go without food for days together with impunity, and with little loss of strength. Another character of true mania is insensibility to external impressions. The maniac will also bear the most intense cold, and gaze without being dazzled on the strong light of the sun.

Other symptoms of less importance have been insisted on, such as the torpid state of the bowels, the moderate or low temperature of the trunk and limbs, a peculiar odour of the skin, and a frequent pulse.*

To this account of the physical signs of mania it may be added that the impostor is apt to overact his part during such times as he is watched; that instead of becoming more quiet and reserved on the approach of the physician, his violence increases; that he assumes a want of intelligence instead of that perversion of reason which is so characteristic of the real affection; that he obtrudes instead of concealing his thoughts; that he pretends a defect of memory and apprehension which does not belong to real insanity, gives false answers to questions, and affects not to recognize persons whom he knows; that he does not recur constantly to the leading idea; that he betrays hesitation in the midst of his assumed violence; that he has not the steady gaze of the madman; that his fits occur suddenly and at irregular and convenient intervals, instead of having the periodicity of intermittent attacks of mania. It may be added, that instead of having the long period of incubation so general in true mania, the first attack of his disorder is sudden. That perversion of the moral feelings which causes the madman to dislike every person to whom he was previously attached, being a symptom little known to the vulgar, is also not assumed by the impostor.

Besides the diagnostic marks to be gleaned from the foregoing description, and the precautions already mentioned under the head of feigned diseases, some special tests have been recommended; such as repeating to the suspected person a series of ideas recently uttered

* In the first edition of this work I adduced facts to show that the value of the pulse as a diagnostic mark had probably been exaggerated. All, perhaps, that can be safely affirmed is that an infrequent pulse, which often exists in healthy persons, would scarcely be compatible with mania.

when the real maniac will introduce new ideas, but the impostor will deem it expedient to repeat the same words. The use of the whirling chair is also recommended, as producing giddiness and nausea in the impostor.

Partial Intellectual Mania.—Monomania.—Melancholia.—These partial forms of mania are less frequently feigned than general mania, and rarely with success. Many of the characters of mania already described are present in cases of intellectual mania springing out of some excited motion, such as pride or vanity. There is the same irritability of temper, the same violent prejudices, the same unfounded aversions and equally unfounded attachments, the same sleeplessness, the same insensibility to impressions, and to the operation of medicines. The pretended monomaniac makes a more open display of his assumed delusion than the real monomaniac, who rarely solicits attention. The true monomaniac is generally reserved, taciturn, and indifferent, but is easily excited and angered by opposition and argument. When hard-pressed men generally take refuge in violence and women in tears.

The forms of intellectual insanity most commonly assumed, and most difficult to distinguish, are those which consist in the assumption of a single delusion, or of profound melancholy; and it is obviously difficult to lay down any diagnostic marks by which the real disease can be distinguished from the false. The difficulty of diagnosis is seriously enhanced when, as sometimes happens, the malingerer is a good actor, and makes a faithful copy of the words and acts of a madman with whom he has been brought in contact.

Moral Mania, general and partial.—As the character of the act or acts committed is the chief ground for believing in the existence of this form of unsoundness, there is no certain means of distinguishing the real from the feigned disease. It is, however, so unlikely that a sane man would commit a murder, for which no motive could be discovered, with the certainty of being hanged if found sane, and imprisoned for life if pronounced mad, that we may fairly assume a homicide, accompanied by all or many of the characters already pointed out, to have been the result of real moral insanity. The personal and family history of the accused would also afford some presumptions in favour of or against the theory of insanity. Of general moral insanity it may suffice to state that the strange combination of foolish, obscene, and cruel acts which make up the history of the true disease, places a serious difficulty in the way of the impostor.

Concealed Insanity.—The power of concealing his delusions, under the influence of a sufficiently strong motive, has already been shown to belong to the madman; and long-continued observation, repeated interrogations, and careful inquiry into the patient's previous history may be necessary to bring the delusions to light.

RULES FOR THE EXAMINATION OF PERSONS SUPPOSED TO BE OF UNSOUND MIND.

Under this head it is proposed to give a few simple directions as to the chief points to be attended to in the several examinations which the medical man may be required to institute.

1. Observe the general appearance of the individual, the shape of the head, the conformation of the body, the expression of the countenance, the gait and movements, and the speech.

2. Ascertain the state of the general health, and note whether the complexion is pale or florid, and the skin moist or dry. Inquire into the state of the digestion, whether the appetite is good, bad, or variable, and the bowels costive or loose, the tongue furred or clean. Ascertain whether the individual is restless or tranquil, whether the sleep is sound and continuous or disturbed and broken; whether he is susceptible of heat and cold, or the reverse. In females the state of the menstrual functions should be ascertained.

3. Inquire into the history of the person's family, with a view especially to ascertain whether he has any hereditary predisposition to insanity, whether any members of his family have been subject to fits, or have betrayed any marked eccentricity of behaviour.

4. If the mind appear unsound, ascertain whether the unsoundness dates from birth, or from infancy, or from what time. If the unsoundness has supervened later in life, did it follow any severe bodily illness, any accident, any mental shock, or long-continued anxiety of mind, or repeated epileptic fits? Have the habits of life been regular or the reverse, temperate or intemperate?

5. Does the present state of mind differ materially from that which existed when the party was reputed of sound mind? Have his feelings, affections, and domestic habits undergone any marked change?

6. When the inquiry is directed to ascertain the capacity of the mind, inquire as to the person's knowledge of his birth-place, of the profession or occupation of his parents, the number of his brothers, sisters, and near relations; as to his recollection of persons and events remote and recent. Does he know his own age? Is he conscious of the lapse of time, and can he name the month, the year, and the day of the week? Does he know the name of the reigning monarch, and of those persons who are most frequently subjects of conversation? Can he perform the simple operations of arithmetic, and does he know the value of money? Can he repeat those simple forms of words which are in general use, such as the Lord's Prayer? Note his power of attention, and distinguish carefully between mere negative or affirmative answers to leading questions, and such as indicate judgment and reflection. If the inquiry relate not to the capacity of the mind, but to its soundness in other respects, we should endeavour to discover the existence of delusion by conversation directed to those topics which are most likely to interest and excite the mind. If the unsoundness

affects the moral feelings rather than the intellect, the relations and friends of the individual should be made the subject of conversation. In cases of supposed moral insanity, inquiry should be made into the motives which may have led to the commission of the act of which the party is accused.

7. When undergoing examination in a court of law, the medical witness should carefully avoid all definitions of insanity, on the plea that mental, like bodily diseases, do not admit of definition, but are subjects for description; and that diagnosis in most cases must depend upon a comparison of several combined symptoms. The medical man should also insist on having sufficient opportunity of forming his opinion. He should rarely content himself with a single visit, and in cases of difficulty should require the party to be placed for some time under his observation.

8. When required to sign certificates of lunacy, the medical man should bear in mind that he is required to visit the patient by himself, to sign the certificate at the time of the visit, and to assign the reasons which have influenced him in attaching his signature.

PART II.

CHAPTER I.

PERSONS FOUND DEAD.—REAL AND APPARENT DEATH.—SUDDEN DEATH.—SURVIVORSHIP.

UNDER the title of *Persons found Dead* it is proposed to consider those general precautions which should be observed in conducting inquiries concerning persons whose mode of death is unknown. As the first question which would naturally be raised is as to the reality of death, the subject of *Real and Apparent Death* follows in order; then *Sudden Death*, in which some of the more common modes of dissolution are briefly considered; and, lastly, *Survivorship*.

PERSONS FOUND DEAD.

In treating of Medical Evidence instructions were given as to the best mode of stating facts and opinions in a court of law, so as to give them their full force, and to render them admissible as evidence. In this place, some brief directions will be given for observing and collecting that important class of facts which refers to persons found dead.

In almost all medico-legal cases, but especially in those referring to persons found dead, the two functions of a *common* and of a *skilled* witness, are combined. The medical man is cognizant of two orders of facts, those which require no interpretation from him, and those from which he is expected to draw his own inferences. If sent for to a dying man, or to one already dead, and subsequently required by the coroner to make an examination of the body, he must of necessity observe many things connected with the body itself, such as the position in which it is placed, and the objects by which it is surrounded, which might just as well be observed and stated in evidence by any other person; but the post-mortem inspection must be intrusted to himself or to some other skilled member of the profession. Hence the present inquiry branches off into two divisions. 1. The relation of the body to surrounding objects. 2. Directions for the performance

of post-mortem inspections for legal purposes: in other words, directions as to the best mode of performing the duties of a *common* witness and of a *skilled* witness respectively.

1. RELATION OF THE BODY TO SURROUNDING OBJECTS.

The medical man is summoned to most cases of severe illness or sudden death, and thus becomes one of the first witnesses of those simple facts, which, in criminal cases, constitute the presumptive or circumstantial evidence. He is also, in most cases, by far the best educated and most intelligent witness. Whenever, then, he is called to visit the dying or the dead, under circumstances of suspicion, he should be alive to all that is passing around him, that no object, however trifling, which may possibly throw light on the cause of death, may be overlooked. The following are some of the principal points to which his attention should be directed:—

The place in which the body is found.—The place in which a body is discovered is not always that in which death actually took place; for, in suicidal as well as homicidal cases, persons severely wounded may be able to move to some distance from the spot on which their injuries were received, and the murderer sometimes tries to conceal his crime by carrying the body to a place remote from the scene of violence.

The position of the body.—The position of the body does not always correspond with the cause of death. Thus the body of a man killed by a blow on the head was found in an upright position, supported by a wooden fence. Murderers often dispose of the bodies of their victims in such a way as to make it appear that they died by their own hands. Thus, persons who have been poisoned have been suspended by the neck, or thrown into the water; and the body of Sir Edmundbury Godfrey, who had been violently strangled, and which bore distinct marks of that mode of death, was found lying in a ditch, pierced with his own sword, and with his clothes so arranged as to create the belief that he had died by his own hand.

The spot on which the body is found.—It is often highly important to examine carefully the spot on which a body lies. In the case of fatal injury to the head, it is usual to allege that the death was caused by a fall on some hard, resisting body; an allegation only to be rebutted by an examination of the spot. Thus, the death of a man found lying in a field with a severe bruise on the head, having been attributed to a fall on a stone, or fragment of wood, the field was carefully searched, and no such object could be found near the spot on which the body lay. In another case, a small wound in the head, which had penetrated to the brain, and had been received during a murderous struggle, was attributed to a fall on a sharp object, such as a nail fixed in the floor; but the floor having been examined, and no such object found, it followed that the wound had been inflicted by

some small pointed instrument. The murderer after his acquittal, which was due to defective medical evidence, confessed that he had struck his victim with the point of a pair of snuffers.

The soil or surface on which the body lies.—It rarely happens that a struggle takes place without leaving on the spot itself some traces which may be compared with the clothes of the suspected murderer or of his victim. Foot-prints on the soil, for instance, have often furnished impertant evidence. Thus Sir Walter Scott gives an account of a murder discovered by the print of the murderer's foot left on the clay floor of a cottage in the death-struggle. The measure of the foot, the tread, and the mode in which the sole of one of the shoes had been patched, corresponded most closely with the foot-mark; and this was the first link in the chain of evidence which led to the conviction of the murderer. Cases of murder, followed by the suicide of the murderer, are of occasional occurrence. When the two crimes have been committed in the same room important light has been sometimes thrown on the transaction by finding stains of blood on the floor and on the sole of the foot of the perpetrator of the double crime.

Position of surrounding objects.—In suicidal cases the instrument of death is generally found lying near the body; in homicidal cases it is often removed and concealed. In cases of death by the more active poisons, the poison is often found on, or close to, the person. The close correspondence of wounds or bruises found on a dead body with the objects immediately surrounding it sometimes throws great light on the cause of death. Thus, in the case of the Prince de Conde, who was found suspended by the neck in his bed-room, the correspondence of certain abrasions found on the legs with a heavy chair placed close to them, and of others on the shoulder with a projecting part of the window to which he was suspended, harmonized with the struggles of a man suspended during life, and gave strong confirmation to the opinion of those who attributed the death to suicide.

The Clothes.—Having noted the place and spot on which the body lies, the position of the body, and the objects by which it is surrounded, a more close inspection should be made of the body itself. The clothes may be covered with mud, or corroded by an acid, or stained by blood, or some animal secretion; or they may be torn or cut. The character and position of the stains, and the direction of the rents or cuts, should be carefully noted.

The cuts should be examined to see whether their size, shape, and direction coincide in the several garments, and whether they correspond with wounds found on the body itself; for it may happen that a murderer tries to conceal his crime by cutting the clothes after he has wounded the body, and that the wounds and incisions do not coincide.

It is scarcely necessary to state that crimes have often been discovered in consequence of the close correspondence of things found in the possession of an accused person with things used in the perpetration of the crimes themselves.

The bearing and conduct of the parties in attendance on sick, dying, or dead persons should not be overlooked; and it is especially important to notice it in cases of suspected secret poisoning.

The foregoing are some of the points to be attended to in respect of persons found dead; but neither examples nor rules can do more than suggest the sort of inquiries which may be necessary. There must always be great scope for individual judgment, foresight, and decision. To the correctness of a good observer the medical witness must add the intelligence and invention of an acute experimenter. The service which an intelligent medical witness may have it in his power to render to the cause of justice cannot be better illustrated than by a case, for which the author is indebted to the late Dr. James Reid. It is given, as nearly as possible, in his own words :—

"I was sent for one day to a man and his wife, whom I found lying in the same room with their throats cut. The woman lay on the floor with her right arm extended under the bed, and a razor close to her right hand. Her throat was deeply cut from ear to ear, and she lay in a complete pool of blood. The husband, who was in bed, had received a wound in the throat, which had merely divided the trachea without wounding any important blood-vessel, and without causing any great loss of blood. When questioned, he gave the following account :—In the middle of the night he was roused from sleep by receiving a wound in the throat from the hand of his wife. The shock, the wound, and the loss of blood together, had prevented him from making any resistance or giving any alarm. My suspicions were roused, partly by the man's manner, and partly by observing the water in a basin standing in the room slightly tinged with blood. In endeavouring to find some confirmation of my suspicions, a thought struck me. *I turned up the bed-clothes, and found the sole of the foot covered with dried blood.* I stated this fact to the jury at the coroner's inquest: a verdict of guilty was immediately returned, but the man died almost at the moment that the sentence was passed."

2. EXAMINATION OF THE BODY.—POST-MORTEM INSPECTION.

The medical man having discharged the duty of a common witness by noting all those points of presumptive or circumstantial evidence which may throw light on the mode and cause of death, proceeds to the examination of the body itself. When the body is that of some person unknown, those characteristics which may lead to its identification should be noted down, in accordance with the instructions given at p. 8. Those appearances which serve to denote how long the party has been dead (see the next chapter) should next be observed, and then the external injuries which the body may have received.

If any wounds, contusions, or excoriations exist, their nature must be specified, and their extent determined by exact measurement. The neck, back, and limbs should be examined, with a view to ascertain

whether any dislocation or fracture exists; the chest compressed, to ascertain whether blood or any fluid mixed with air or gas escapes from the mouth or nostrils; the cavity of the mouth inspected, in search of foreign bodies or stains of corrosive poisons; and the anus for poisons introduced into the body by that opening. In new-born children the orbits, fontanelles, and nuchæ should be inspected in search of minute wounds inflicted by pointed instruments. In women the points of junction of the breasts, especially on the left side, with the skin of the chest, should be examined, in search of minute wounds. The female organs of generation should also be examined in search of poisons, corrosive acids, or wounds.

Post-mortem Inspection.—The great rule to be observed in conducting post-mortem inspections for medico-legal purposes is to examine every cavity and important organ of the body. Even when the cause of death is quite obvious, it is well to observe this caution; for if any part of the body have been left unexamined, the objection may be made that the cause of death might have been found there, or some disease which would have given a mortal character to an injury not otherwise fatal.

The order in which the great cavities of the body are examined must depend, in part, on the supposed cause of death. As a general rule the seat of injury should be inspected first, before the contents of the blood-vessels have been disturbed by the examination of other parts.

Chaussier and other French authors have given unnecessarily minute directions for performing post-mortem examinations for legal purposes. Such examinations are not likely to be performed in a hasty or slovenly manner.

Specific directions for post-mortem examinations in cases of rape, delivery, poisoning, infanticide, &c., are given under those heads.

REAL AND APPARENT DEATH.

The subject of real and apparent death has never attracted much attention in England, and no medical author of reputation has treated it at any length.

In earlier periods of our history persons ran some risk of being buried alive, but this risk has now disappeared, and is not likely to recur unless in the improbable event of some fatal epidemic malady rendering speedy interment expedient. But the question of real or apparent death may assume a practical importance long before the usual period of interment arrives. In cases of suspended animation, the adoption, neglect, or speedy abandonment of the measures usually resorted to with a view of restoring life, must depend on the previous answer to the question—Is life really extinct?

On the Continent, and especially in France, this subject of real and apparent death is treated with greater respect, and has employed the pens of such distinguished modico-legal writers as Winslow, Bruhier, and

Louis, and has received some attention at the hands of Mahon, Foderé, and Orfila.

The greater importance attached to the subject abroad is accounted for by the practice of early interment, and by the Roman Catholic rite of extreme unction, which raises a serious impediment to the use of means for restoring animation.

There are three forms of suspended animation which may be mistaken for real death—syncope, asphyxia, and trance.

1. *Syncope.*—There is good reason for believing that, in the majority of instances, the apparent death, about which so much has been said and written, was merely a state of prolonged syncope. The success attending the accidental employment of the very means that are found most efficacious in restoring those who have fainted, namely, cold water and fresh air, seems to prove this. The efficacy of cold water is attested by Hippocrates in the case of a woman apparently dead from fever, and by John Howard, who bears his personal testimony to the restoration of persons supposed to be dead of the gaol fever, and brought out for burial, on being washed with cold water!

The efficacy of pure and cold air in producing the same result rests on the authority of Diemerbröck and Zacchias in cases of plague; and well-authenticated instances of similar recovery after small-pox are on record. One of these occurred in the person of an infant daughter of Henry Laurens, the first President of the American Congress. She had the small-pox, and was laid out as dead; but the window of the apartment that had been carefully closed during the progress of the disease being thrown open, the fresh air revived the supposed corpse, and restored her to her family.

Such cases as these were not of infrequent occurrence before the time of Sydenham, who abolished the stifling system of treating eruptive diseases, especially small-pox. The acknowledged existence of cases of prolonged syncope after febrile and eruptive diseases gives probability to cases in which recovery from a state of apparent death is alleged to have occurred at the touch of the scalpel, or, in ancient times, under the flame of the funeral pyre.

2. *Asphyxia.*—This is a form of suspended animation of very frequent occurrence. It is being continually mistaken for real death, and can be distinguished from it only by the result of the means employed for the recovery of the patient.

3. *Trance.*—Cases of suspended animation, not answering exactly to the description of syncope or asphyxia, occasionally occur in females. The motionless and insensible state of the frame, the coldness of the surface, and the suspension of the functions of respiration and circulation, combine to produce a semblance of death, and to create temporary difficulty even for the medical man.

The subject of real and apparent death would be incomplete if some notice were not taken of those cases in which a state of apparent death has been brought about by an effort of the will. The occasional

occurrence of such cases has been placed beyond the reach of doubt; and a minutely-described and well-authenticated instance of this kind, that of the Honourable Colonel Townshend, is related by Cheyne in his 'English Malady.'

"He told us, he had sent for us to give him some account of an *odd sensation* he had for some time observed and felt in himself; which was, that composing himself, he could *die* or *expire* when he pleased, and yet, by an *effort*, or somehow, he could come to life again: which, it seems, he had sometimes tried before he had sent for us. We all three felt his pulse first: it was distinct, though small and thready, and his heart had its usual beating. He composed himself on his back, and lay in a still posture some time; while I held his right hand, Dr. Baynard laid his hand on his heart, and Mr. Skrine held a clean looking-glass to his mouth. I found his pulse sink gradually, till at last I could not feel any by the most exact and nice touch. Dr. Baynard could not feel the least motion in his heart, nor Mr. Skrine discern the least soil of breath on the bright mirror he held to his mouth. Then each of us by turns examined his arm, heart, and breath, but could not by the nicest scrutiny discover the least symptom of life in him. This continued about half an hour. As we were going away (thinking him dead) we observed some motion about the body, and upon examination found his pulse and the motion of his heart gradually returning; he began to breathe gently, and speak softly." This experiment was made in the morning, and he died in the evening. On opening the body nothing was discovered but disease of the kidney, for which he had long been under medical treatment, all the other viscera being perfectly sound.

This case of Colonel Townshend is not only curious but instructive, as it renders it in the highest degree probable, that there may be states of system so nearly resembling death as even to deceive medical men, and distinguishable from real death only by the continuance of animal heat and the absence of rigidity, and by the success of the means of restoration.

The fact that there are certain states of the living system which may for considerable periods closely simulate death admits of important practical application. It teaches us that we should not hastily abandon the attempt to resuscitate persons who have appeared to perish by syncope or asphyxia, or in whom life seems to have in any way become extinct. This caution is especially needed in cases of apparent death from hæmorrhage, shock, sun-stroke, drowning, and the several forms of suffocation.

Signs of Death.—Of the signs of death insisted upon by authors some are trivial and inconclusive, others of considerable importance, both as signs and as means of forming a judgment of the time that life has become extinct. To the first class belong the Cessation of the Circulation and Respiration; the absence of sense and motion; the Facies Hippocratica; the State of the Eye; the State of the Skin; and the Extinc-

tion of Muscular Irritability. To the latter class belong the Extinction of Animal Heat; Cadaveric Rigidity; and Putrefaction.

The Cessation of the Circulation.—If no pulse can be felt on applying the finger to the wrist, and the beat of the heart can neither be felt nor heard, it is fair to assume that the circulation of the blood has ceased. It is possible, indeed, that very feeble movements of the heart might escape observation; but whether the heart cease to beat altogether, or contract so feebly as not to make itself perceptible to the hand or ear, is of little consequence, as the fact of life having been restored after its contractions had been apparently suspended for a time, as in the remarkable case of Colonel Townshend, is enough to deprive the test of all practical value.

The Cessation of the Respiration.—The two functions of circulation and respiration are so closely connected, that what is true of the one is likely to be true of the other. The tests of respiration—the looking-glass, the feather, and the cup of water placed on the chest or abdomen—are at least as delicate as those by which we seek to determine the continuance of the heart's action. It is scarcely possible that respiration should take place in any degree, and yet escape detection by such means; and yet in the case of Colonel Townshend, the looking-glass remained for a long period unsoiled, and no trace of respiration could be detected. The suspension of the respiration, therefore, like the cessation of the circulation, is not to be regarded as a sure sign of death.

The same remarks apply to the joint cessation of the respiration and circulation as to the cessation of either separately.

The Absence of Sense and Motion.—As these negative states are present in all cases of suspended animation, they are not to be considered as signs of death. The combined loss of voluntary motion and sensibility is not of rare occurrence in hysteric females, and it is present in the mesmeric slumber; but in these cases the functions of circulation and respiration go on uninterruptedly, and a careful observer will sometimes detect a vibrating movement of the eyelid, which forms an exception to the general rule of immobility.

The Facies Hippocratica.—This shrunk and sharp expression of countenance, combining the sunken eye, the sharp nose, the pointed chin, the hollow temple, the prominent cheek-bone, the projecting ear, the wrinkled brow, the dry livid skin, and the white powdered hair of the nostrils and eyebrows, is a trivial and unsafe sign of death, open to the serious objections:—

That it is nearly always absent in cases of sudden death, and in the victims of acute disease.

That it is present in the dying as well as in the dead, and has been observed where recovery has taken place.

That it may be brought about by a strong impression of danger, the apprehension of a dreadful punishment, or the anticipation of certain death; and that where it exists, it does not long survive the extinction of life.

The State of the Eye.—The formation of a tenacious glairy mucus on the conjunctiva, occasioning a loss of transparency in the eye and a collapsed and wrinkled state of the cornea, are among the best and earliest of the trivial signs of death. But they are not conclusive; for, on the one hand, the conjunctiva may be invested by a mucous film and the cornea may lose its brilliancy in the living, and, on the other hand, these appearances are absent in some forms of death. In death from *apoplexy*, from *carbonic acid*, and from *prussic acid*, the eyes may preserve their brilliancy and prominence for a long time. Putrefaction, too, by distending the cavities of the body with gas, sends blood to the head, and makes the eyes brilliant and prominent; and Nysten produced this state of the eyes in the dead body by introducing substances in a state of fermentation into the stomach.

The State of the Skin.—*Pallor* of the skin, owing to the absence of circulation; *livid discolourations*, the result of the subsidence of the blood; and *loss of elasticity*, have been mentioned among the signs of death. Pallors of the skin may exist during life, and it is not present in several forms of death, especially in death from suffocation. Livid discolourations, too, may exist in aged and feeble persons in depending parts of the body. But loss of elasticity is a sign of considerable value and very early developed.

The Extinction of Muscular Irritability was recommended by Nysten as a certain criterion of death. He proposed to lay bare a muscle and test it by puncture or by the galvanic fluid. The absence of contraction was justly assumed to be a sign of death, but its presence could only be taken to prove that the body was either alive or recently dead.

Among the trivial signs of death, the flexure of the thumb across the palm of the hand may be mentioned. The thumb assumes this position before cadaveric rigidity comes on, but it is similarly contracted during life in certain spasmodic affections.

The foregoing signs of death do not supply us with the means of determining how long life has been extinct. But the extinction of animal heat, rigidity, and putrefaction, being the only certain signs of death, and also means of determining, with more or less precision and certainty, the period at which death took place, are worthy of being examined more closely.

SIGNS OF DEATH WHICH ARE ALSO MEANS OF DETERMINING HOW LONG LIFE HAS BEEN EXTINCT.

Extinction of Animal Heat.—The temperature of the body is closely dependent on the circulation of the blood; so that when this ceases, in a part of the body or in the entire frame, that part, or the whole body, soon becomes cold. Hence the extremities become cold before death; and as the circulation becomes more and more languid, even the internal parts of the body cool down, as is shown by the low

temperature of the breath as it issues from the lungs; and at length, when life is extinct, all the parts of the body become cold. But as, on the one hand, great coldness of the body is often present during life, and in cases of suspended animation, and, on the other hand, in cases of sudden and violent death the body often parts with its heat very slowly, the value of this sign of death is impaired. An anomalous restoration of heat to the body, without any other sign of life, has also been observed to take place after death by cholera.

Nor is the extinction of animal heat a very sure means of determining the period at which death took place; for the rate of cooling of the body varies with the age and cause of death, the treatment of the body itself, and the state of the atmosphere; so that the period of cooling may vary from two or three hours to fifteen or twenty, and may even extend to upwards of four days.

The body cools slowly when covered with clothing and exposed to a warm, still atmosphere, quickly when exposed naked to a draft of cold air. It parts with its heat more speedily in water than in air. Age, emaciation, and death by hæmorrhage or chronic disease favour the cooling of the body; youth and vigour, corpulence, and acute disease or speedy death retard it. In persons falling victims to the same disease, the extinction of animal heat is, *cæteris paribus*, as the rapidity with which they prove fatal. In chronic diseases, the body parts with much of its heat during life.

Cadaveric Rigidity.—For some time after life is, to all appearance, extinct, the muscles continue to contract on the application of stimuli. The extreme duration of this irritability, even in the muscles of voluntary motion, does not exceed two hours; and when it ceases, cadaveric rigidity sets in.

This phenomenon occurs in all classes of animals alike, and is the first certain evidence of death. It was originally supposed to commence only with the complete extinction of the animal heat; but it is now known to make its appearance long before the body has cooled, and to commence in those parts which lose their heat the latest. It is confined to the muscular system; for so long as the muscles remain entire, the limbs continue inflexible, unless great force be used; but when they are cut or torn, the rigidity ceases. It takes place in all positions of the body, and whether the limbs be flexed or extended, and it does not change the positions which the several parts of the body had at the time of death. It shows itself first in the muscles of the trunk and neck, then in those of the upper extremity, then in those of the lower; and it disappears nearly in the same order; the muscles of the lower extremity often remaining rigid when those of the trunk and upper extremity have resumed their state of relaxation. It is entirely independent of the nervous system, for it makes its appearance after the nerves have ceased to be excited by the galvanic fluid. A division of the nerves, or even the removal of the entire brain, does not prevent its occurrence; and in death from apoplexy or

hemiplegia, the paralyzed limb is affected in the same way, and to the same extent, as the sound one.

Cadaveric rigidity is strongly marked and persistent in muscular subjects, and, as a general rule, it lasts long when it sets in late. In death by lingering diseases, such as low fever, consumption, and scurvy, and the diseases of old age, the rigidity sets in very speedily, and disappears again in the course of one or two hours. On the other hand, in death by acute inflammation of the stomach or viscera, by irritant poisons, whether mineral, vegetable, or aerial (provided they exert no specific influence on the contractile powers of the muscles), the rigidity is for the most part slow in making its appearance, strongly developed, and lasts for a considerable time. After death from spasmodic cholera it is said that rigidity has commenced very early, and has not ceased till after the lapse of four or five days. It is slow in showing itself in death from apoplexy, hæmorrhage, wounds of the heart, decapitation, injury of the spinal marrow, and asphyxia. Its duration in poisoning by carbonic acid is very considerable, and in one case Nysten found that it continued seven days. On the other hand, in poisoning by sulphuretted hydrogen gas, rigidity does not occur.

Cadaveric rigidity cannot be mistaken for any other condition of the dead body. The stiffness caused by intense cold would be readily distinguished from it by the ease with which the limbs are moved.

The rigidity of the muscular system present during life in such diseases as catalepsy and tetanus does not need to be distinguished from cadaveric rigidity. If any distinction were necessary, it might be drawn from the effect of bending an extremity forcibly: if the rigidity were due to a vital contraction, the limb would be restored to its position, which would not happen in the rigidity of death.

Rigidity, then, is a certain sign of death, and a state not to be confounded with any existing in the living body, or in any form of apparent death. Supervening, too, as it does, after the extinction of muscular irritability, it is a sure indication of the hopelessness of our attempts at resuscitation.

Putrefaction.—This, too, is an infallible sign of death, not requiring to be distinguished from any condition of the living body.

As the march of the putrefactive process affords some means of judging of the period at which death took place, it will be necessary to describe the changes which it occasions in the body with some degree of minuteness.

In the interval which elapses between the extinction of life and the commencement of the putrefactive process, the body falls more and more under the influence of physical laws. The skin loses its elasticity, and the flesh its firmness, and the blood, which was equally distributed through the body by the action of the heart and the elasticity of the arteries, now obeys the laws of gravity, and falls to the most depending parts of the corpse. Hence the paleness of some parts and the deep violet tint of others, the discolouration of the

occiput and back, of the depending parts of the intestines, and of the posterior part of the lungs.

As the body is usually placed on the back, this cadaveric lividity is found on the posterior parts of the body and of the internal organs; but if the body be placed on the face, it will occupy the anterior part of the body and of the viscera. If again, after discolourations have formed on the back, the body be turned while still warm, and before the blood has coagulated, they will disappear. These discolourations are often very extensive, and, if the body is placed on a smooth surface, uniform in tint; but if the surface is uneven, the discolourations are interrupted and irregular. The pressure of the clothes produces the same effect; so that a careless observer might mistake the marks of clothes fastened round the neck for the effect of strangulation, or isolated patches for severe bruises.

The extent and amount of discolouration are proportioned to the quantity of the blood which the body contains; the general prevalence, therefore, of cadaveric lividity through the whole body indicates a general fulness of the vascular system. On the other hand, its absence shows that a small quantity of blood exists in the body. Sudden death unattended by hæmorrhage or effusion of blood, is characterized by extensive lividity; but after death preceded or caused by hæmorrhage, the skin is remarkably pale, and presents but faint traces of such discolouration.

This subsidence of the blood explains a fact of some medico-legal importance, namely, the diminished intensity of colour in parts which had been the seat of the less severe and more diffuse forms of inflammation. But the appearance produced by such acute inflammation as follows burns and scalds, blisters, and strong friction on the surface, and the action of the more violent irritant poisons on the internal parts, are permanent, and quite distinct in the dead body.

Cadaveric lividity is said to be distinguished from the effect of injuries inflicted during life by the seat of the discolouration being in the rete mucosum and vascular membrane which lie exterior to the true skin. The vessels of these parts are filled with dark blood, so that the cut surface presents a black line from which the blood may be expelled by pressure. The dermis or true skin is white. But in the discolourations of the skin produced by the afflux of blood *during life* the tissue of the true skin is injected with blood, and exhibits when divided a number of bloody points. This discolouration of the tissues external to the true skin, is, however, not an invariable occurrence; for on comparing a vertical section of the integument from a part of the back deeply discoloured by cadaveric lividity, with a similar section from a highly inflamed portion of skin, the first was found to be quite free from vascular injection, while the last presented a number of red spots of extravasated blood. The two sections were mounted side by side, treated in every way the same, and examined by the same power of the microscope.

Besides these discolourations produced by the blood which follows the course of the vessels, there are others due to the transudation of the fluids. Thus the parts in immediate contact with the gall-bladder are deeply tinged with bile; and the aqueous humours of the eye transuding, cause the dull and collapsed appearance of the cornea.

The subsidence of the blood and the transudation of the fluids partly explain that relaxed and softened state of the tissues which is the first of the series of changes usually attributed to putrefaction. These fluids next undergo changes of colour, and tinge the several textures with brown, blue, or green discolourations, according to the degree of decomposition which they have undergone.

The exudation of fluids is followed by the development of gases in the several cavities of the body, especially in the abdomen. This takes place sometimes so rapidly, and to such an extent, as to change the position of the body. In consequence of the resistance offered by the walls of the abdomen and chest, the internal viscera and their contents suffer displacement. The diaphragm is thrust upwards, the contents of the large vessels are forced towards the head and neck, the face swells, the eyes become prominent, and a mucous or bloody fluid flows from the mouth and nostrils. In rare instances the contents of the bowels are forced out. Blood also exudes from wounded or ruptured vessels, leading to post-mortem hæmorrhages and extravasations. Of old, much importance was attached to this post-mortem bleeding of wounds, and if it happened to coincide with the touch of the criminal supposed to have inflicted them, he was summarily convicted of the murder.

There is reason to believe that the development of gas (probably carbonic acid) in parts of the body filled with blood often precedes the other common signs of putrefaction. I have seen this early formation of gas both in the lungs and beneath the membranes of the brain. (See Infanticide, p. 89.)

As putrefaction advances, the cuticle becomes detached, the muscles grow viscid and pulpy, assume a dark-greenish colour, and exhale a highly offensive odour; and at length the whole texture of the body becomes changed into a soft semi-fluid mass, which gradually parts with its moisture, dries up, and leaves a fibrous fatty residue, slowly lost in the soil.

Sometimes these processes of putrefaction and decay go on very rapidly, and are soon completed; at other times they are extended over many years, the rapidity with which they take place depending greatly upon the circumstances in which the body is placed. When the process of putrefaction is once established under favourable circumstances it goes on rapidly, the parts already decomposed acting as a sort of leaven to the rest.

The conditions which affect the progress of putrefaction, and enable us to form an opinion as to the time at which death took place, are Temperature, Moisture, and Access of air, Period, Place, and Mode of Interment, Age, Sex, Condition of the Body, and Cause of Death.

Temperature.—Putrefaction is arrested by a temperature of 212° and of 32°: in the former case the body is reduced to dryness by the evaporation of the fluids; in the latter the fluids are congealed. The most favourable temperature is one ranging from 70° to 100°. Putrefaction, therefore, takes place more rapidly in summer than in winter, and, other things being equal, varies with the temperature.

Moisture.—This is an essential condition, and without it putrefaction cannot begin, or, having begun, cannot continue. The body contains, in all its parts, moisture enough to insure decomposition; but those parts, such as the brain and eye, which contain the largest quantity of fluid are most prone to putrefaction, and dropsical subjects putrefy speedily.

Putrefaction commences soon, and runs a rapid course, in inflamed parts, in bruises, and at the edges of wounds.

Bodies which have remained for some time in the water, and are then exposed to the air, putrefy more rapidly than those which have not been immersed; but in bodies which remain in the water putrefaction goes on slowly, from the contact of air (another condition highly favourable to putrefaction) being prevented.

On the other hand, dryness of the air retards or arrests putrefaction. Hence the preservation of the bodies of travellers on sandy deserts.

A rapid current of air has the same effect as dry air, by causing rapid evaporation. On the other hand, a moist and stagnant atmosphere encourages putrefaction, by retarding evaporation no less than by supplying moisture.

Access of Air.—That the presence of atmospheric air promotes putrefaction is shown by the slow development of gas which takes place when blood or flesh is introduced into a vessel through mercury, so as to exclude all the air which does not attach to the substance introduced: also, on the other hand, by the preservation of flesh in atmospheres not containing oxygen, such as hydrogen and nitrogen; less completely in atmospheres in which oxygen is chemically combined with some other gas, as in carbonic acid and nitrous acid; also in atmospheres filled with vapours that absorb oxygen, such as turpentine. The well-known antiseptic quality of the contents of common sewers is explained partly by the exclusion of air, and partly by the presence of gases not containing oxygen. Oxygen, when taken separately, promotes putrefaction more than any other gas whatever, but when combined with nitrogen, as in atmospheric air, its activity is greatly increased.

It appears, then, that heat, moisture, and the free access of air, are the conditions most favourable to putrefaction. In judging, therefore, of the period at which death took place, we should consider well what amount of influence each of these agents has brought to bear on the result.

Period, Place, and Mode of Interment.—Period.—Bodies putrefy much more speedily in air than in the ground. Hence the longer in-

terment is delayed, the greater the changes produced by putrefaction. Thus, Orfila observes, that if, during the summer, a body be kept exposed for five or six days, and then interred, it will be found, at the end of a month, to have undergone as much change as it would have done at the end of seven months, if it had been interred at once.

Site.—In dry elevated situations, putrefaction goes on slowly; in low swampy grounds, rapidly. *Soil.* A dry absorbent soil retards, a moist one accelerates, putrefaction. In sand or gravel the change goes on slowly, and adipocere is rarely met with. In marl or clay, and in loose mould, especially that which is impregnated with animal or vegetable matter, more quickly (except peat, which clearly retards putrefaction). The deeper the grave, *cæteris paribus*, the slower the putrefaction. The more completely the body is defended from the air by clothes or coffin, the more slowly does putrefaction go on. It is rapid where the body is exposed to the soil, but very slow where it is buried in a coffin hermetically sealed.

The several media retard putrefaction in the following order:—

1. Water of common sewers and cesspools. 2. Common water. 3. The earth (in different degrees according to the character of the soil). 4. The air (in different degrees according to its temperature, moisture, &c.).

Consult Orfila's 'Traité des Exhumations Juridiques,' and Devergie's 'Médecine Légale,' which contains the marrow of Orfila's observations, with his own account of the changes produced by putrefaction in the water. The process of putrefaction as it occurs in water will have to be examined by itself.

Age.—Other things being equal, the bodies of children putrefy more speedily than those of adults and aged persons, and the bodies of old persons undergo this change more rapidly than those of the adult.

Sex.—According to Orfila, putrefaction takes place more rapidly in females than in males. He attributes this to the greater quantity of adipose matter with which their cellular membrane is loaded. This explanation, though not quite satisfactory, agrees with the fact, that the bodies of fat persons undergo this change more readily than those of the lean and emaciated.

Condition of the Body and Cause of Death.—Putrefaction takes place more or less speedily in proportion as the body is more or less filled with fluid. Accordingly, it is very rapid after sudden death, and after death from *acute* disease; more slow after death from hæmorrhage, and from chronic disease, unless complicated with dropsy. After death from inhaling carbonic acid (judging from three cases mentioned by Devergie in the 17th vol. of the 'Annales d'Hygiène') putrefaction is also greatly retarded.

The same observation applies to the parts of the body as to the entire frame; for those parts which are filled with fluids at the time of death, through inflammation, congestion, or dropsy, or in consequence

of wounds or bruises, putrefy more rapidly than healthy and entire structures.

It was formerly believed that the bodies of persons destroyed by poison putrefied very rapidly; but it is now well known that arsenic, and the other mineral poisons, act as powerful antiseptics. Animal and vegetable poisons have probably no effect either way; but persons poisoned by them putrefy rapidly, as in other cases of speedy death. There is reason to believe that putrefaction takes place with unusual rapidity in animals driven soon after a meal and dying suddenly; as well as in men dying suddenly during violent exertion.

Putrefaction in Water.—More dependence is to be placed on the criteria laid down for determining the period of death in those whose bodies have remained in the water, than in those who have been exposed to the air or interred, for the obvious reasons, that the temperature of the water is more uniform, and the body, unless when it rises to the surface, is protected from the air. As Devergie, whose official position at the Paris Morgue has given him unusual means of observation, places much reliance on the signs by which the period of death is determined in the drowned, the following account based upon his description is subjoined.

The bodies of the drowned are subject, like those who perish by other modes of death, to loss of heat and rigidity, and to putrefaction in a modified form, accompanied by the formation of adipocere. One of the first changes, which may be seen as early as the third or fourth day, consists in a bleaching of the skin of the hands.

At the end of a week the body is found supple, and the skin of the palms of the hands very white.

A week to twelve days of immersion bleaches the backs of the hands, and softens and bleaches the face.

At the end of a fortnight the hands and feet are bleached and wrinkled, the face slightly swollen with spots of red, and the middle of the sternum has a greenish tint.

At the end of a month, the hands and feet are completely bleached and wrinkled as if by a poultice, the eyelids and lips are green, the rest of the face reddish-brown, and the front of the chest presents a large patch of green with a reddish-brown spot in the centre.

At the end of two months, the face is swollen and brown, and the hairs are but slightly adherent: much of the skin of the hands and feet is detached, but the nails have not separated.

At two months and a half, the skin and nails of the hands are detached, and the skin of the feet, but the toe-nails are still adherent. In the female, reddish discolouration of the sub-cutaneous cellular tissue of the neck, of that which surrounds the trachea, and of the organs contained in the cavity of the chest; partial saponification of the cheeks and chin; superficial saponification of the mammæ, the axillæ, and the anterior part of the thighs.

At three months and a half. The skin and nails of the hands and

feet completely removed; part of the hairy scalp, of the eyelids, and of the nose, and the skin of many parts of the body destroyed; and the face and upper part of the neck and axillæ partially saponified.

At four months and a half. Nearly total saponification of the fat of the face, of the neck, of the axillæ, and of the anterior part of the thighs; commencing earthy incrustation of the thighs; incipient saponification of the anterior part of the brain; opaline state of the greater part of the skin; almost entire separation and destruction of the hairy scalp; calvarium denuded and beginning to be very friable.

As to the more remote periods no accurate approximations can be given; but Devergie alleges that the above signs have been repeatedly applied with complete success to bodies that have remained in the water for periods unknown at the time of their examination.

The foregoing description applies to bodies immersed during winter and spring. Bodies immersed in summer undergo the same changes much more rapidly. Thus, 5 to 8 hours of immersion in summer correspond to 3 to 5 days in winter; 24 hours to 4 to 8 days; 48 hours to 8 to 12 days; 4 days to 15 days. Thus on the average the same changes in summer take place from three to five or six times as rapidly as in winter, or even more promptly than that. The changes in spring and autumn are intermediate between those of winter and summer.

This account of the changes which take place in the bodies of the drowned would be incomplete without some further notice of that development of gas within the body which causes it to rise to the surface. This takes place slowly in winter, and the body rarely rises to the surface in less than six weeks or two months. But the same change takes place in summer from the 14th to the 16th day, or even earlier. In some instances the body is found to float at a much earlier period than either of those now indicated.

Frequent mention has been made of *adipocere*. This substance derives its name from the resemblance it bears to a compound of wax and fat. It is formed by the union of the margaric and oleic acids, arising from the decomposition of the fat of the body, with the ammonia generated during decomposition. It is, therefore, a sort of animal soap.

Adipocere is formed in bodies which remain for a long time in water, also in bodies buried in moist soils, and especially where a large number of bodies have been interred in one common grave. A body must remain about three years in the ground in order that it may be completely transformed, but the change takes place much more rapidly in water. In bodies which remain in the water the development of adipocere may commence as early as the third or fourth week.

Adipocere is sometimes of a pure white colour, sometimes of a yellowish or brownish white. Bodies wholly converted into this substance have a ghastly bleached appearance, but retain their form, so as to admit of identification.

SUDDEN DEATH.

Under this title it is intended to point out some of the common causes of sudden and speedy death, and to indicate those appearances in the dead body which throw light on the true cause of death in the more obscure cases. That such cases are not of uncommon occurrence will be inferred from the fact that no less than from 3,500 to 4,000 sudden deaths occur year by year in England and Wales from causes not ascertained; this number being over and above the 15,000 deaths returned as due to violent causes, of which the greater number also belong to the class of sudden or speedy deaths.

A temporary suspension of the heart's action constitutes the chief sign and the essence of apparent death; a total arrest of its contractions is real death. Some of the vital endowments of the blood and muscles survive this cessation of the heart's action; and the lingering irritability of the heart itself, and especially of the right auricle, forms our ground of hope in the use of means of resuscitation. This suspension or total arrest of the heart's action, or, in other words, apparent or real death, may be brought about by different causes, of which some act directly on the heart, and others indirectly through the medium of the lungs.

The causes of sudden death which act directly on the heart are either—1. Structural diseases of the heart itself, and of the large vessels, or 2, Nervous shocks paralyzing its muscles, or 3, Causes cutting off the supply of blood to it, or 4, Causes destroying the stimulant property of the blood.

1. The structural diseases of the heart and large vessels, such as disease of the valves, hypertrophy, aneurism of the aorta, and ossification of the heart, aorta, or coronary arteries, are readily discovered on post-mortem examination. The only diseases of the heart which might escape observation are atrophy and fatty degeneration of the muscular tissue; and there is reason to believe that both of these causes are occasionally overlooked. In some instances, as in two cases related by Mr. Paget, death really due to fatty degeneration was believed to have been caused by poison.

2. The nervous shocks of sufficient force to paralyze the heart, and to cause instant or speedy death, may be caused by strong and sudden emotions of fear and joy, by the lightning and sun-strokes, by heavy blows on the head or pit of the stomach, by violent exertion giving rise to sudden effusion of blood on the brain (of which one case has come under the notice of the author), by large drafts of cold water swallowed when the body is heated, and by a few of the more active poisons given in full doses.

3. The supply of blood necessary for the heart's action may be cut off by profuse hæmorrhage. It may also be kept from the left side of the heart by the arrest of the circulation through the lungs in death by apnœa. But this belongs to the class of indirect causes.

4. The proper constitution of the blood may be destroyed by the mechanical admixture of air introduced into the veins during operations on the neck, shoulder, or axilla; or it may be chemically destroyed by poisons, directly introduced into the circulation. This contamination of the blood plays an important part in death by all the more active and deadly poisons, whether inhaled or swallowed.

Of the causes of sudden or speedy death which act indirectly upon the heart, the most common is that arrest of the circulation through the lungs which attends the several forms of suffocation. A similar arrest of the pulmonary circulation constitutes the intermediate link between the less severe shocks to the nervous system and the ultimate arrest of the heart's action.

Several of the foregoing causes of sudden death are at once revealed by a careful inspection of the body; but those causes of death which do not leave behind them any structural change may yet give rise to such marked changes in the distribution of the blood through the body, and in and about the heart, as to aid us very materially in our inquiries into the true cause of death. Thus, death from the rapid loss of blood would be indicated by pallor of the surface, and the empty and contracted state of all the cavities of the heart; death from shock suddenly arresting the circulation, by a distended state of all the cavities of the heart; and death from suffocation by violet patches on the surface of the body, and distension of the right side of the heart with dark blood.

The causes of sudden death, and the post-mortem appearances by which they are indicated, may be more fully discussed by adopting the well-known classification of Bichat; namely, death beginning at the *head*, death beginning at the *heart*, and death beginning at the *lungs*.

Sudden Death commencing at the Heart.— Syncope.— The phenomena which attend this form of death are:—Pallor of the face and lips, cold sweats, dizziness, dimness of vision, dilated pupils, gasping and sighing respiration, a slow, weak, and irregular pulse; to which are sometimes added nausea and vomiting, restlessness and tossing of the limbs, transient delirium and convulsions.

On inspecting the body, the vessels generally are found to contain but little blood, and the *heart to be nearly or quite empty, and contracted.* This empty state of all the cavities of the heart contrasts strongly with their distended state in the rare cases of death originating in the brain, and acting directly upon the heart; and not less strongly with the distended condition of the right side of the heart, and empty state of the left, which occurs in death commencing in the lungs.

Sudden Death commencing at the Head.—Injuries to the nervous centres may act directly upon the heart, and put a stop to its contractions: or they may first affect the function of respiration by paralyzing the respiratory muscles. When the heart is directly affected, the

circulation is, as it were, arrested and fixed in what may be termed its normal state, each side of the heart containing its due proportion of blood, and all the cavities being distended from the sudden loss of power in the heart to propel its contents. This mode of death has been designated *asthenia*. When, on the contrary, the muscles of respiration are paralyzed, the post-mortem appearances will be those presently to be described under the head of apnœa.

Sudden Death commencing at the Lungs: Apnœa (Asphyxia).—The sense now affixed to the term asphyxia departs strangely from the original derivation of the word, which means pulselessness. It is now understood to mean real or apparent death due to a suspension of the function of respiration,—a mode of death much more aptly designated by the term *apnœa*.

Apnœa may be produced by a great variety of causes, of which the chief are:—

1. Cessation of the action of the muscles of Respiration. 2. Cessation of the action of the Lungs themselves. 3. Exclusion of the atmospheric air from the Lungs.

1. *Cessation of the Action of the Muscles of Respiration* may be due to *inertia* of the muscles themselves, in consequence of cold or debility; to *a loss of nervous influence supplied to the muscles*, as from division of the upper portion of the spinal marrow, or of the pneumogastric and phrenic nerves, from the lightning stroke and from apoplectic seizures; to *mechanical restraint*, as by pressure on the chest or abdomen; or to *tonic spasm*, as in death from Tetanus or Hydrophobia.

2. *Cessation of the Action of the Lungs*.—This may be due to a division of the eighth pair of nerves; or to a mechanical obstacle, such as the admission of air into the pleura, or the entrance of the viscera of the abdomen through a wound in the diaphragm.

3. *The partial or complete Exclusion of Atmospheric Air from the Lungs* may be brought about by the entire absence of air, as in a vacuum; or by its extreme rarefaction, as on the top of very lofty mountains. The air, again, may be mechanically excluded, as by a foreign body introduced into the larynx, by submersion, by suffocation, by strangulation, by suspension. Or lastly, the place of the atmospheric air may be taken by a gas, such as nitrogen or hydrogen, which cannot support respiration. Other gases seem to exercise a deleterious influence on the economy, independent of the mere exclusion of the air. Some of these are intensely irritating, as the sulphurous acid gas, chlorine, and ammonia; others, though less irritating, are not less fatal in their effects, such as the carbonic acid, carbonic oxide, carburetted hydrogen, nitrous acid, hydrosulphuric acid, hydrosulphate of ammonia, arseniuretted hydrogen, and the vapour of hydrocyanic acid. Some of these, as well as the more simply irritant gases, may act mechanically by producing a spasm of the glottis, and closing it against the admission of air.

To this list of the causes of apnœa may be added certain diseases of

the lungs, as hepatization, œdema, or tubercular infiltration, which prove fatal by filling the air-cells, and preventing the process of respiration from being duly performed.

The *symptoms* of apnœa will be more or less strongly marked according as the asphyxiating cause acts suddenly or slowly. If the atmospheric air is suddenly excluded from the lungs, as by mechanical compression of the trachea, complete submersion, or the inhalation of a gas which is so irritating as to cause spasmodic contraction of the glottis, the symptoms are strongly marked, and run a rapid course.

The sufferer struggles violently for breath, and uses strong efforts to remove the obstruction. The face at first flushes, but soon grows turgid and livid; the veins of the head and neck swell; the eyeballs start from their sockets; and the swollen tongue protrudes between the teeth. A short attack of giddiness, with bright spots before the eyes, and ringing sounds in the ears, is followed by loss of consciousness, convulsive movements of the limbs, and relaxation of the sphincters, with expulsion of the urine and fæces and more generally of the prostatic fluid. In two or three minutes, if relief be not afforded, life is extinct.

When the asphyxiating cause acts more slowly, the symptoms are somewhat modified, and succeed each other at longer intervals.

There is a feeling of constriction in the chest, from which the sufferer strives to free himself by strong voluntary efforts to inspire air, or by the involuntary efforts of yawning or sighing. A dull heavy pain in the head, especially over the forehead, with giddiness, dimness of sight, and torpor of the intellectual faculties succeed, and gradual loss of sensation and voluntary motion. Still, the functions of respiration and circulation continue, as shown by almost imperceptible movements of the walls of the chest, and pulsations of the heart scarcely sensible to the hand. This imperfect state of respiration and circulation is followed by the entire cessation of those functions, and by complete loss of motion, voluntary and involuntary. At this point of time the fulness of the capillary system begins to show itself, by the injected state of the face, and by a deep violet discolouration of that part, which also extends to the hands and feet. Some portions of the trunk and extremities exhibit spots, more or less extensive, of the same colour. At length, the capillary circulation ceases, and the state of apnœa is complete.

In some cases the asphyxiating cause, acting more slowly still, seems to induce a sleep which terminates, without suffering, in death; in other instances, the sensations are even pleasurable, consisting of a display of beautiful colours or of pleasant landscapes before the eyes. There is still another class of cases in which the sufferer, suddenly roused from a state of torpor to a vivid and painful perception of his state, makes an effort to escape from the death which threatens him, but finds his muscular strength unequal to the accomplishment of his purpose, and falls to the ground.

After death the body presents the following appearances:—Patches of rosy, bright red, or violet, discolouration are seen on the face or on other parts of the body, as much on the least as on the most depending parts. The eyes are usually prominent, firm, and brilliant. The mouth is sometimes expressive of calmness, at others of suffering. Cadaveric rigidity is very marked, and continues for a long time. The venous system of the brain is commonly full of blood, but its substance presents, when divided, but few bloody points. Sometimes the ventricles of the brain contain serum; sometimes blood is effused at the base in the substance or on the surface of the organ. The base of the tongue is almost always injected, and its papillæ strongly developed. The lining membrane of the epiglottis, larynx, and trachea, is of a deep red colour, and the colour increases in intensity as we approach the last ramifications of the air-tubes. The air-passages often contain a frothy sanguinolent fluid. The *lungs* are so much distended and increased in size as to project over and conceal the pericardium. They are of a deep violet colour, and when cut into and compressed, large drops of black, thick, liquid blood exude. The liver, the spleen, and the kidneys, are also gorged with blood. The veins of the heart are distinctly traced upon its surface, its right cavities and the large venous trunks are gorged with black, thick, liquid blood; but the left cavities of the heart are found nearly or quite empty.

Such are the appearances present in death by apnœa when it occurs in its unmixed form; and they are those observed in the bodies of persons who have perished by inhaling carbonic acid. But all these appearances are not present in every case, nor, if present, are they equally marked in all.

Theory of Apnœa (*Asphyxia*).—When air is prevented from gaining access to the lungs, the blood does not undergo its usual change from venous to arterial, and venous blood does not minister to the support of the vital functions of the several organs so completely as the arterial blood does. Some, indeed, have supposed that venous blood is a positive poison; and that it is much worse for an organ to be supplied exclusively with venous blood than to receive no blood at all.

On this assumption, the cessation of the heart's action may be explained in one of three ways. The heart may be paralyzed by the circulation of the venous blood through the coronary arteries in place of arterial blood; or the venous blood may be unfitted to excite the left cavities of the heart to contraction; or, again, the nervous influence supplied to the heart from the nervous centres may be suspended by the circulation of venous blood through the nervous tissue.

But the assumption that venous blood is directly poisonous, and worse than no blood at all, has been disproved, as far as it can be, by experiment. Kay has shown that the venous blood exercises no deleterious influence on the muscles, by comparing the contractility of a

limb from which the supply of arterial blood has been cut off with that of a limb supplied exclusively with venous blood; and Edwards found that a cold-blooded animal placed in an asphyxiating medium lives longer than one whose heart and bulb of the aorta have been excised.

Venous blood, therefore, is not positively, or to a great degree, injurious; its circulation is merely a negative injury, and destructive of life by occupying the place of arterial blood and cutting off the supply of that fluid to the economy. As the absence of all circulation through the vessels of the heart, or through those of the brain, or through the nerves supplying the heart with vital stimulus, would certainly and speedily prove fatal to life, so would the mechanical exclusion of arterial blood from the vessels of those parts, whether by warm water or by venous blood. This theory of exclusion, then, is adequate to the explanation of death by apnœa. It has been shown, however, by Dr. Kay, that neither this theory, nor the theory of poisoning by a deteriorated blood, is the true one; but that the essential character of this form of death consists in the accumulation of blood in the lungs and right cavities of the heart, and a diminished supply of that fluid to its left cavities; so that the quantity of blood sent out for the supply of the system constantly diminishes, till at length the circulation is altogether arrested. Hence in death by asphyxia the left ventricle is found contracted, and nearly or altogether empty. It is of little consequence to inquire into the proximate cause of this arrest of the circulation through the lungs; the fact is all with which, as medical jurists, we have to do.

On contrasting the post-mortem appearances proper to the three modes of death, syncope, asthenia, and apnœa (asphyxia), it will be seen, that in the first, all the cavities of the heart are empty or contain little blood; in the second, all the cavities are full of blood; and in the third, the right side is gorged with blood, while the left ventricle contains little or none.

It is most important, however, that the medical jurist should bear in mind that the characteristic appearances of sudden death, due primarily to the heart, the lungs, or the brain, are not always equally marked; that they may be combined with each other in different proportions; and that a cause usually productive of the one may, in certain circumstances, give rise to the other. Thus, a person may be threatened with suffocation (one of the causes of apnœa), and apprehension may give rise to sudden *syncope*; or a violent attempt to escape the threatened injury may burst a blood-vessel in the brain, and cause *apoplexy*. We must, therefore, bear in mind the possibility of such combinations as these, in order that we may be prepared to understand the different appearances presented by those who perish from a common cause.

It may be useful to subjoin the following facts connected with sudden death.

From the 19th Annual Report of the Registrar-General, it appears that of 416,470 deaths from all causes, occurring in England and Wales, on the average of the five years 1852-56, 13,711, or about 1 in 30, were violent deaths, of which 3045 were due to various forms of chemical injury, 3826 to apnœa (asphyxia), and the remaining 6840 to various mechanical injuries. Of the 13,711 violent deaths, 10,057 occurred in males, and 3654 in females. The sudden deaths, for the average of the same five years, are stated at 3843 or more than 1 per cent. (1 in 109). They are distributed between males and females in the proportion of about 3 to 2.

The suicides on the average of the same five years amounted to 1083, of which 777 in men and 306 in women. Of 1044 due to ascertained causes, 642 were brought about by various forms of suffocation, 111 by poison, 1 by burning, and the remainder by mechanical injuries, among which 210 cut throats, 43 gun-shot wounds, 12 other wounds, and 20 falls. The suicides by poison by men and women respectively were as 6 to 5, by apnœa as about 3 to 1, and by mechanical injuries at about 4 to 1. The greatest number of suicides in both sexes occurred between the ages of 45 and 55. The relative frequency of the several forms of sudden death appears, from a work of Ferrario and Sormoni on sudden deaths occurring in Milan, to be as follows :—

Head (including apoplexy, cerebral concussion, vertigo, and coma) . .	879	or about 4 in 5.
Heart (including diseases of the heart, angina pectoris, aneurism, and hæmorrhage).	150	or about 1 in 7.
Lungs (including asphyxia, suffocative catarrh, and pulmonary apoplexy) .	14	or about 1 in 75.
Difficult labours	5	
Total . . .	1048	

The relative frequency of the different forms of sudden death classified according to their proximate causes must, however, be understood to differ at different periods of life. The proportions just stated are obviously those which obtain chiefly among adults; for sudden deaths in infancy and childhood, if classed according to their causes, would reverse the order just stated. By far the most common cause of death in infancy and childhood is to be found in the lungs, and the least common in the brain, though the fact of convulsions being very common in early life might lead a superficial observer to attribute the majority of sudden deaths to the brain and not to the lungs. The diseases of the lungs which give rise to sudden or speedy death in infants and young children are spasmodic croup or laryngismus stridulus, to which Dr. West attributes three out of four of the sudden

deaths of children under one year old, imperfect expansion of the lungs at birth (atelectasis pulmonum), sudden collapse of the lung, consolidation from pneumonia, and sudden serous effusion into the pleura, to which ought to be added a disease not mentioned by Dr. West in the paper now referred to, pulmonary apoplexy. A not uncommon cause of sudden death among the children of the poor is suffocation, as a consequence of drinking hot water from the spout of the kettle. Next to diseases of the lungs, sudden death by exhaustion from insufficient food, or chronic diarrhœa, is most common, while fatal disorders of the brain are very rarely to be set down among the causes of sudden death in infancy and childhood.

Of the sudden deaths entered in the tables of the Registrar-General upwards of one-third occur in infancy.*

SURVIVORSHIP.

When two or more persons die by the same accident, a question sometimes arises as to which died first; for, in certain cases, the succession to property would be secured on proof of survivorship even for an instant of time.

Hitherto little has been done towards establishing broad general principles applicable to this class of inquiries: indeed, the materials for the establishment of such principles are wanting. Some of the more accurate results which have been attained will be found stated in the following pages under the following heads:—1. Of the probabilities afforded by age and sex, irrespective of the mode of death. 2. Of the degree in which such probability is affected by the peculiar mode of death.

1. *Of the Probabilities afforded by Age and Sex.*

Age.—As the body attains its full growth and strength at about 27 years of age, or from 25 to 30, and, in healthy persons, continues strong and vigorous up to about 50, there will be no sufficient ground for inferring survivorship in the case of adults of the same sex, whose ages range between 25 and 45, or even between 20 and 50, provided the form of death is one in which mere strength of frame and power of endurance is concerned. Before and after the ages specified, the strength and power of endurance will be less, but still within the limits of puberty and old age (say 15 and 60 years) the difference will probably be inconsiderable. The probability of survivorship, in the case of a middle-aged adult perishing with one under puberty or above 60, will be in favour of the adult. In the case of one under 15 and one above 60 perishing together, the French law assumes that the former survived: when both are under 15, that the elder outlived the younger. According to the civil law of England, if parent and

* See a Lecture by Dr. West, on Sudden Death in Infancy and Childhood in the 'Medical Times and Gazette,' Nov. 26, 1859.

child perish by a common death, the child shall be presumed to have survived if above puberty, and to have died first if under puberty.

In the case of a mother and child both dying in childbed, without assistance, the presumption is, that the mother survived, for there is a chance of still birth, and a further probability that the child, if born alive, would die before the mother would be able to render the assistance necessary for its preservation. A large child would be still more likely to perish first, for it has been elsewhere stated (p. 84) that still-born children greatly exceed in size and weight those born alive. If the body of the child could be examined the presumption might be still further strengthened by the external marks of a difficult labour, or the absence of the signs of respiration. Legal decisions have not been always in conformity with the principle here laid down.

Sex.—If one of either sex perish by a common accident, it may be inferred that the male, being the stronger, is the survivor; but this rule applies only to modes of death in which strength and courage give the best chance of safety. On the other hand, females being subject to prolonged fainting in consequence of fright, may be, by that very circumstance, incapacited from those struggles which in so many forms of death may be presumed to increase danger. When, then, there is safety in exertion, the probability of survivorship will be with the male; where passive endurance or insensibility would tend to lessen the danger, with the female.

2. *Of the Degree in which the foregoing Probabilities are affected by the Mode of Death.*

Under this head it is proposed to specify some of the more common modes of death, and to endeavour to establish some general principles with respect to them, assuming, as before, that the parties about whom the question is raised are placed, as nearly as may be, in the same circumstances.

Apnœa (Asphyxia).—Women consume less oxygen than men; the same quantity of air, therefore, will last them for a longer time. Hence, of adult males and females perishing together of apnœa, the females may be presumed to have survived. In poisoning by carbonic acid gas, which is nearly allied to death by apnœa, the chances of survivorship are with the female. This statement rests on the authority of a large number of facts. In 19 out of 360 cases of poisoning by carbonic acid, which took place in Paris during 1834 and 1835, a man and woman were exposed to the fumes of charcoal together: of these three only were saved, and these three were females. In solitary cases of the same form of death the result is also favourable to the female; for 18 out of 73 females were restored, and only 19 out of 83 males, so that the chances for the female and male respectively are nearly as 15 and 14 (instead of 5 and 4 as Devergie represents it). Single cases are in strict conformity

with this result. Thus, in a case quoted by Beck from the 'Transylvania Journal,' a man and his wife were exposed in a small room to the gas from live coals. The man was found dead, rigid, and contracted, but the woman was still breathing and recovered. Again, in a case reported by M. Sardaillon, a man, his wife, and their child aged seven years were asphyxiated in a porter's lodge. The child died, the father was very ill and with difficulty restored to life, while the wife was well enough to call for help and to assist both husband and child. In these cases it would be necessary to take into account the position which the parties occupied in the room, whether on the bed or on the floor, near to or remote from an open window, &c.

Drowning.—There are many complicated considerations connected with this mode of death. In shipwrecks men are more likely to be in a favourable situation for saving themselves, as they are more on deck than women; they also in many instances are able to swim, or to save themselves by clinging to portions of the wreck, and they are less encumbered by clothing. When the comparison is between men similarly exposed and capable of the same exertion, it may be necessary to inquire whether one was more exposed to cold by having the body half immersed, while the other was more under water. Search should also be made for severe injuries which may have prevented the swimmer from using his strength, or may have otherwise proved fatal. Apoplexy is stated by Devergie to be sooner fatal than apnœa, while in death by syncope there is the best chance of recovery.

Suffocation.—In all cases of suffocation depending upon an insufficient quantity of air, or upon air rendered partially unfit for respiration, it may be presumed that those who require least air live the longest—women longer than men, children than adults. In suffocation from the falling of houses or earth, or by mechanical means in general, the stronger may be presumed to survive the weaker—men, women; adults, children and old persons.

Cold.—As young children bear cold worse than adults, the probability of survivorship in exposure to the same degree of cold is in favour of the latter. Men bear cold better than women, adults better than the aged. It is necessary also to take into account the clothing of the persons exposed, and their state of health. Spirituous liquors in excess increase the effect of cold; in moderation they give increased tolerance of it.

Heat.—The young and old, as they suffer more from cold, so do they bear heat better. The relative tolerance of heat of the two sexes is not well ascertained. Foderé relates the case of an Englishman and his daughter aged seven years, who, in the year 1814, crossed the desert of Syria to the Persian Gulf. Both rode on camels, and were placed in precisely similar circumstances, but the father died, while the child arrived in safety at its journey's end.

Hunger and Thirst.—Those who have not reached their full growth require more nourishment than adults, and adults more than aged

persons. The aged, then, if healthy and robust, may be presumed to survive both, and the adult to live longer than the child. Corpulent persons are thought to bear hunger better than the emaciated. In death from starvation, those who have the freest access to water may be presumed to live the longest. Those who use the greatest exertions will suffer earliest in this as in the foregoing modes of death. Those who possess most passive endurance may be expected to live the longest.

Such are some of the principal forms of death, in which the circumstances of the several victims are likely to be so similar as to admit of the application of general rules. In other modes of death, and in these under certain circumstances, there may be no points admitting of strict comparison, and many things which may exercise a marked influence on the result will have to be taken into the account. The reader will find several such cases quoted in Beck's 'Medical Jurisprudence;' but as they throw little light upon the general question, and establish no fixed principles, it would be useless to quote them.

It has been suggested by more than one writer, that a distinct enactment would be preferable to the present custom of deciding each case on its own merits. Such an enactment, extending to that large class of cases in which the circumstances of the death are but imperfectly known, and to those in which it is in the very nature of things impossible to come to a correct decision, is certainly much to be desired. On many points, as it has been seen, the opinions of medical men can throw much light, and their researches lead to general principles admitting of tolerably safe application.

CHAPTER II.

DROWNING—HANGING—STRANGULATION—SUFFOCATION.

THESE modes of death are brought together in the same chapter, as they are all forms of apnœa, or sudden death beginning at the lungs.

DEATH BY DROWNING.

The medico-legal importance of this cause of death may be inferred from the fact, that on an average of the five years 1852-56, 2352 deaths were caused by drowning, of which 1847 in males and 505 in females. Of this number 164 (87 males and 77 females) were ascertained acts of suicide.

Although death by drowning is commonly attributed to apnœa, it is not always due to that cause. Hence this subject is not so simple as at first sight it would appear to be. To make it intelligible it will be necessary to describe the various modes in which a man found in the water may have come by his death, *supposing him to have died in the water.*

When a man in perfect possession of all his faculties falls into the water, he sinks to a greater or less depth, but immediately rises to the surface again; and, if he is a swimmer, makes efforts to save himself, till at length he is reduced to the condition of one who cannot swim at all; with this difference, that he has already exhausted the strength which the other has in reserve for the death-struggles common to both. These struggles consist of irregular movements of the arms and legs, and graspings of the hand at all objects within reach, whether floating in the water, fixed at the bottom of it, or growing on the banks. In the course of these irregular movements he rises repeatedly to the surface, tries to breathe, and takes in air and water. The contact of the water with the windpipe causes a cough, by which part of the fluid is rejected, and with it some of the air contained in the lungs. This occurs again and again, till the body no longer rises to the surface; water alone is received in the vain efforts to respire, while forcible involuntary expirations continue to expel the air from the lungs. At length all these efforts cease, the body sinks to the bottom of the water, and bubbles of air are forced from the chest by the elastic reaction of its parietes. The greater part of the water which has been taken in finds its way into the stomach, and a smaller portion into the lungs; and this portion, mixed with the

secretions of the mouth and air-passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way.

In cases belonging to the class just described, we may expect to find the appearances proper to death by apnœa, coupled with those due to the medium in which the death takes place. In the case of the swimmer death may take place from exhaustion, with only indistinct signs of death by suffocation.

But death may take place in the water, and yet be caused neither by apnœa nor by exhaustion. There may be a complete loss of consciousness at the very moment of immersion. This may happen from fright, from drunkenness, from an attack of hysteria, or of catalepsy (of which latter the author has known one melancholy instance); and in this case the body falls to the bottom of the water, rises again to a certain height, and sinks without a struggle. In these cases death is due to shock, or to syncope, and not to suffocation.

Again, a person may fall or throw himself into the water with the head foremost, and, striking against a rock or fragment of wood, or even against the surface of the water itself, perish by concussion; or the body falling or thrown from a height may strike the water with the chest and pit of the stomach, so as to cause instant death from shock. In these cases, also, death is due to causes other than apnœa.

Again, cold, excitement, or the first violent struggles, may occasion apoplexy, or sudden death from disease of the heart. These sudden deaths by diseases of the brain and heart are of occasional occurrence in persons bathing in cold shallow water.

Death by drowning may also be of a mixed character. A man falls into the water in the full possession of all his faculties; he preserves them for a time, till, struck with horror at the death which threatens him, he faints, and thus perishes.

It appears, then, that death by drowning may be due to apnœa, to exhaustion, to shock or syncope, and to apoplexy; and, further, that death may be brought about partly by apnœa and partly by one of the other causes now specified. The cases in which marks of apnœa more or less distinct are found in the body, either separately or blended with those proper to some other form of death, form the great majority, and cases in which the signs of apnœa are wholly absent a small minority, while cases of pure and unmixed apnœa occupy an intermediate place. Devergie, whose opportunities of experience in this class of cases have been already alluded to, estimates the cases of unmixed apnœa as *one in four* or *two in eight* of the whole, the cases in which no traces of apnœa exist as *one in eight* of the whole, and the mixed cases as *five-eighths* of the whole.

The appearances present in the body of the drowned must of necessity vary with the manner and precise cause of death.

In those cases in which death has been due to *apnœa*, the post-mortem appearances will be those proper to that mode of death

(see p. 223), but blended with those due to the medium in which the death happened, and modified by the time that the body has remained in the water, as well as by the period of exposure to the air after removal from the water.

Supposing the death to have been due to apnœa, and the examination of the body to be made soon after the death and removal from the water, it may be expected to present the following appearances:— The face and general surface of the body are either pale or slightly livid, with occasional patches of a deeper tint. The expression of the face is generally calm. The tongue is swollen, and closely applied to the teeth, rarely protruded between the closed jaws, and still more rarely wounded and bloody; and there is a frothy foam at the mouth. The air-passages also contain a froth, which is sometimes tinged with blood; and the trachea and larger bronchial tubes contain water which sometimes penetrates to their most minute ramifications. Sometimes the water is in such quantity as to fill the whole of the air-passages, and it occasionally carries with it portions of slime or mud, or fragments of aquatic plants.

The lining membrane of the air-passages is sometimes found congested; the lungs contain a large quantity of black fluid blood; the venæ cavæ and right cavities of the heart are distended with dark blood, while the left cavities and aorta are comparatively empty. The stomach almost always contains water, of which the quantity is sometimes very considerable. The intestines have a rosy colour; the liver, spleen, and kidneys are gorged with blood; and the bladder sometimes contains urine tinged with blood. The brain presents the same appearances as in other cases of death by apnœa. Sand or mud are often found in the hollow of the nails, the fingers are sometimes abraded, and portions of plants growing in the water, or on the banks of the stream, are sometimes found grasped in the hands. Injuries received in falling into the water during the death-struggles, or through the violence of the stream, may also leave their marks upon the body. These will presently be more minutely described.

In bodies which have remained in the water, or been exposed to the air for some time, the pallid, or slightly livid hue of the features just described may be exchanged for a bloated appearance, and large livid spots may show themselves on different parts of the body, as in other cases of death by apnœa.

In death by shock, syncope, or exhaustion, there is little or no water in the air-passages or in the stomach. The cavities of the heart and large vessels are equally distended with blood, or are nearly empty, and the brain and internal viscera are in their natural state.

Death by concussion or by apoplexy, or by disease of the heart, will reveal itself by the usual post-mortem appearances.

In mixed cases the post-mortem appearances due to apnœa will be less strongly marked. There will be less froth at the mouth, less water and froth in the air-passages, and in the stomach; and less

congestion of the lungs, of the heart and great vessels, and of the internal viscera.

Several medico-legal questions suggest themselves in reference to a body found in the water, of which the first in order is the following: —*Was death caused by drowning?* In the case of a person found dead in the water, the death may obviously have happened from natural causes or from intentional violence prior to the immersion; and in the latter case the death may have been due to some cause producing apnœa, and giving rise to the characteristic appearances proper to that mode of death. In other words, a person may be strangled or suffocated, and then thrown into the water to conceal the true cause of death. In forming a decision on a question of so much difficulty, we shall have to consider the several post-mortem appearances alleged to be characteristic of death by drowning, and to determine whether they might have been occasioned by causes acting before immersion. We must also determine whether, in the case of bodies remaining in the water some time after death, the appearances usually attributed to the mode of death may not be explained by the peculiar circumstances in which the body is placed.

Of the post-mortem appearances present in bodies found in the water, some are common to death by drowning and to death by other forms of apnœa, while others are peculiar to death by drowning. To the first class belong the position and swollen state of the tongue; the pallor with rosy or violet discolorations of certain parts of the skin; the injected state of the brain; the congestion of the internal viscera; the fulness of the right cavities of the heart, and emptiness of the left; the fluid state of the blood; and the existence of bloody urine in the bladder. To the second class belong:—excoriations of the fingers, with sand or mud in the hollow of the nails; fragments of plants grasped in the hand; water in the stomach; froth at the mouth and nostrils; and froth, water, mud, or sand in the air-passages.

Of the post-mortem appearances belonging to the first class, it will suffice to observe, that their presence in persons found dead in the water is consistent with the supposition of death by drowning, but that they might have been caused prior to immersion by any of the modes of death which act by occasioning apnœa. If the body is free from marks of strangulation, death might still have been caused by suffocation produced by forcible closure of the mouth and nostrils.

The post-mortem appearances alleged to be due to drowning, and to be characteristic of that mode of death, must now be briefly considered.

Excoriations of the Fingers are much more frequently absent than present; but, when they exist, may be regarded as a probable, though not certain sign of death by drowning. They might be caused previous to forcible immersion, by the rubbing of the fingers against any hard and rough body; and possibly after death in running streams.

Sand or mud in the hollows of the nails, also, affords a probability

of immersion during life, inasmuch as it implies, like the excoriations of the fingers, that the drowning man grasps at the bed or banks. But if the body remained long in the water, mud or sand might be deposited in the hollow of the nails.

If the hands were found clenched and *grasping weeds growing in the stream or upon the banks*, there would be the strongest probability in favour of death by drowning.

Water in the Stomach.—The discovery of water in the stomach affords another strong presumption in favour of death by drowning; especially if the water can be identified with that in which the body was found by its containing leaves of plants growing on the banks or at the bottom. Except in the cases presently to be mentioned, it presupposes acts of deglutition during efforts to breathe. It must, however, be admitted to be possible, though very unlikely, that the water might have been swallowed a very short time before submersion.

The quantity of water found in the stomach is very variable; and depends partly upon the number of efforts at respiration made during the act of drowning, and partly on the depth of the water. In animals that have been stunned before immersion, as well as in animals kept under water from the first, and prevented from rising to the surface, the stomach contains no water; while in animals allowed to rise to the surface, it is found to be in proportion to the number of times that the animals so rise.

That the depth of the water also influences the quantity found in the stomach is proved by the experiments of Dr. A. Taylor. The stomach of a cat held two feet below the surface of the Thames contained scarcely any water; but that of a cat lowered to the depth of fifty-five feet contained a large quantity. The stomach of a third cat which was allowed to rise repeatedly to the surface of the water, was distended, but not so much as the one which had been lowered to the depth of fifty-five feet.

The influence of the columnar pressure of the water is, therefore, considerable; and it is probable, that where the water is very deep the pressure of the fluid may overcome the resistance offered by the collapse of the œsophagus, even though the animal died previously to submersion. It appears, moreover, that water may enter the stomach in consequence of putrefaction producing a general relaxation of the tissues.

From what has just been stated, it is obvious that the discovery of water in the stomach is not to be considered as conclusive evidence of death by drowning, when the water is of great depth, or when the body is far advanced in putrefaction. It must also be admitted to be possible that the water might have been swallowed immediately previously to immersion, and possible, also, though most improbable, that it might, as suggested by Orfila, be maliciously injected after death.

But though the discovery of water in the stomach affords a presumption of death by drowning, its absence must not be taken as evi-

dence to the contrary; for it is not present in cases of death by drowning due to causes other than apnœa, such as shock, syncope, concussion, or apoplexy. The tendency to swallow may also be voluntarily resisted; or the body may be, in some way or other, prevented from rising to the surface.

On the other hand, water may have entered the stomach, and yet not be found there after death; for if the head be allowed to hang below the rest of the body, the water will flow from the stomach. This fact also has been proved by Dr. Taylor's experiments. If, moreover, the body is long exposed after its removal from the water, the fluid contained in the stomach may transude through its coats, and disappear.

The absence of water from the stomach, therefore, is not conclusive against death by drowning, for it may have gained access to the stomach, and subsequently disappeared; or it may never have entered the stomach at all.

Froth, water, mud, or sand, in the Air-Passages.—Mucous froth.—The experiments of Piorry and Orfila have clearly shown that the presence of mucous froth in the air-passages is due to the body rising repeatedly to the surface for air, and that it does not exist in animals kept entirely under water.

This froth is also absent when the body remains in the water a long time after death, or is subject to long exposure after its removal from the water, or when the head is placed below the level of the body. The value of this mucous froth as evidence of death by drowning is also impaired by the fact that it exists not only in the several forms of death by apnœa, but in death by apoplexy or epilepsy, and in catarrhal and other affections of the lungs.

Water in the lungs.—That water generally enters the lungs in death by drowning has been abundantly proved by experiments on animals, and by cases in the human subject in which not water only, but sand and mud, have entered the air-passages. By drowning rats in chalk and water, with free access to the air, I have never failed to obtain effervescence by means of acids in every part of the lungs.

But the value of this sign is impaired by the fact that water may enter the lungs of those who have been thrown into the water after death. Orfila and Piorry found, that the quantity which thus gained admission to the lungs, varied according to the position of the body. When it remained upright there was a large quantity; less when horizontal.

It has been suggested that water may be *injected* after death. This is most improbable. But water is not always present in the lungs of those who have died by drowning; for, as in the case of the stomach, if the head is left depending, the water flows out. Long exposure, too, will cause it to transude and be lost.

Froth at the Mouth and Nostrils.—This, too, is a sign of death by drowning; but it is open to all the objections just stated in respect of

froth in the air-passages. It depends, indeed, very closely on the existence of froth in the air-passages, as well as on the development of the putrefactive process, and the consequent generation of gas forcing the froth in the larynx and trachea into the fauces. Hence it is more frequently present in summer than in winter.

From this examination of the signs of death by drowning, it appears that there is no single sign on which entire reliance can be placed. When, however, several signs happen to coincide, the probability is greatly strengthened. Like the symptoms of disease, they may be of little value when taken separately, but when combined they enable us to form a safe diagnosis. Some authors, and Orfila among the number, have, indeed, thought that the question, Was death due to drowning? admits of no decision; but from this opinion Devergie very properly dissents.

It is important to bear in mind, that the appearances characteristic of death by drowning are not permanent. In winter they may continue after the body has lain from fifteen to eighteen days in the water, while in summer they would disappear from the third to the sixth or eighth day of immersion. The exposure of the body to the air also causes them rapidly to disappear, and in the height of summer a few hours would suffice to dissipate them. When putrefaction has gone to any considerable extent, all the signs of death by drowning are of course completely removed.

The time that the body has remained in the water will be determined approximately by the signs laid down at page 217.

The evidence derived from the signs of death by drowning already discussed admits of being confirmed or invalidated by the condition of the body in other respects, especially by the presence or absence of

Marks of Violence.—With regard to injuries discovered on the bodies of persons found in the water, three questions arise:—

1. Were they inflicted during life?

2. If inflicted during life, are they of such a nature as to account for death before submersion?

3. Were the injuries accidental, suicidal, or homicidal?

The first question—whether the injuries were inflicted during life?—and the third question—were the injuries accidental, suicidal, or homicidal? are fully discussed under the head of wounds. The fact of the body having been immersed in water will influence the decision of this question, only in so far as the injuries are altered in appearance by the continuance of the body in the water.

Are the Injuries of such a nature as to account for Death before Submersion?

There are five different ways in which a body taken from the water may come to exhibit marks of violence. 1. A man may be murdered, and, when dead, thrown into the water; 2. He may receive severe injury from the hands of others or himself, and may then be thrown (or throw himself) into the water while still alive. 3. The body may

be bruised by the struggles which the drowning man makes to save himself. 4. It may be borne by the violence of the stream against some obstacle. 5. The body may sustain severe injury in the very act of falling into the water.

1. On the supposition that a man has been murdered and thrown into the water quite dead, we should expect to find an absence of all the signs of death by drowning; with the exception only of such as may be present under certain circumstances already mentioned, such as uncommon depth of water, or advanced states of putrefaction.

2. On the supposition, again, that a man found in the water had first been severely injured and then thrown in whilst still alive, we might expect to find some at least of the signs already mentioned, and these might be sufficiently marked to enable us to come to a decision; but this would, of course, depend on the strength still left to the drowning man, after the violence inflicted upon him.

3. The injuries which the body might sustain through the struggles of the drowning man would not be such as to raise any question of the true cause of death. They would consist of bruises more or less extensive and severe, but not so severe or extensive as to endanger life.

4. The injuries which may be inflicted on the body by the violence of the stream would also consist of bruises more or less extensive. It is very unlikely that such severe injuries as dislocations or fractures could originate in this way.

5. *Falling into the Water.*—There is no doubt that considerable injury may be inflicted if a person falls or throws himself from a considerable height upon a hard bank or pier of a bridge. Fracture of the skull or limbs, extensive bruises, and severe lacerated wounds may be readily accounted for by this cause.

Dislocation of the extremities is also a possible consequence of the mechanical obstacle presented by the water to the body falling from a great height. This accident happened many years since, as stated by Dr. Gordon Smith, to a man who was in the habit of jumping from the parapet of London Bridge into the Thames for a wager. He had previously performed this feat with impunity, but the last time he sank and was drowned. Both arms were found dislocated, in consequence, it is thought, of his having fallen with them in the horizontal position, instead of holding them close to his sides.

Two cases are also recorded (South's edition of Chelius's Surgery, vol. i. p. 532), the one of fracture of the body and arch of the fourth cervical vertebra, the other of fracture of the body of the fifth cervical vertebra, made in jumping into the water, due to the violent muscular effort to avert collision with the bottom, by drawing back the head.

The medical man should, therefore, first ascertain whether the drowned man fell from a height into the water, whether the stream is rapid, and what obstacles present themselves; and if on careful examination he finds that there are no such causes as these to account for the violence which the party has sustained, he may fairly trace that vio-

lence to some cause preceding the immersion. In bodies found in shallow still water, marks of violence afford strong presumption of homicide.

Having convinced ourselves, after a careful examination, that death took place by drowning, another question arises—

Was the drowning the result of Accident, Suicide, or Homicide?—This question is exceedingly difficult to answer. For if there are no marks of violence on the body, it is not possible to say whether the man fell in, or jumped in, or was pushed in. Again, in respect of bodies found in running streams, it may not be possible to ascertain at what point the body entered the water; hence we are deprived of such information as might have been obtained from a close examination of the spot where the body is found.

Nor if we find the hands of the drowned man full of leaves or grass, showing that he struggled hard whilst in the water, can we affirm that he was thrown or pushed in by others; for, if he fell in, he would do precisely the same.

Nor again, does the fact of a man being drowned in a shallow stream of water render the idea of homicide improbable; for if a strong man were to hold the head of a weak or infirm one in a basin of water, he might drown him just as effectually as in a deep stream. On the other hand, it should be borne in mind that cases of suicidal drowning in shallow water, or in very narrow spaces, such as small house-cisterns, are by no means rare.

It is evident, from what has been stated, that where there are no marks of violence on the body, we have no means of determining whether the drowning was the result of accident, suicide, or homicide. Nor does the discovery of external injuries throw any light upon the question, unless those injuries are of such a kind as that they could not have been inflicted by the person himself previous to immersion, or by the accidental striking of the body against an obstacle in entering the water, during the death struggle.

There is one case which would at first sight seem conclusive as to homicide, and that is where a body is found in the water, tied hand and foot. Dr. Smith, however, relates the following case:—In July, 1816, the body of a gauging-instrument maker, who had been missing for some days from his home, was discovered floating down the Thames. On being taken out, his wrists were found tied together and made fast to his knees, which were in like manner secured to each other. He had been in a state of mental derangement for two years. The cord with which he had tied himself was recognised as one that had hung from the ceiling over his bed, and by which he used to raise himself up, as he had been confined to bed for some weeks. He was a good swimmer, and it was presumed he had taken the precaution to prevent himself from employing that power. The verdict in this case was, "Found drowned." Two other cases of a similar kind are on record, one by Foderé, in which the hands and fingers were tied together with a silk riband, in numerous folds; and another in the ninth

volume of the 'Annales d'Hygiène,' in which the feet, wrists, and neck were tied. Foderé in the one case, and the medical examiners (Marc, Guichard, &c.) in the other, gave their opinion in favour of suicide. In such cases as these it would be necessary to determine whether the knots or folds admitted of being made with the teeth, or by any movements of the hands or limbs.

Treatment of the Drowned.—Before describing the proper treatment of the drowned, it may be well to recall the fact that in the majority of deaths by drowning the cause of death is apnœa, simple or mixed; and that the means to be adopted are those which would be prescribed in other cases of suffocation, with certain modifications obviously suggested by the circumstance of the death having occurred in the water. The contact of the water, for instance, will account for a lower temperature of the surface than would exist as a simple consequence of death from apnœa. Hence the necessity for more prompt and sustained attempts to restore the heat of the surface. Such provision as may not be inconsistent with the use of other means of restoration should also be made for relieving the lungs and stomach of the water which had entered those organs.

The following rules for the treatment of the drowned are in accordance with the improved method of the late Dr. Marshall Hall. Strip the body, and carry it, resting on the belly with the face downwards, at once to a house close at hand, or to a convenient spot in the open air; and wipe the body and face dry. Raise the body into the sitting posture, and endeavour to excite respiration by the use of smelling-salts, by tickling the nostrils and throat with a feather, and by dashing warm water on the face and chest. If these means of exciting respiration happen to be at hand, use them promptly, and desist if they do not produce an immediate effect: if not at hand, proceed at once to replace the body on the face with the arms crossed under the forehead. Then turn it to the side and back again to the face about fifteen times in a minute. In the short intervals apply friction and pressure to the ribs, and along the spine, and carry the hands with a firm pressure along the extremities from below upwards. If warmed blankets can be procured place them under and round the body, and rub the body with hot towels. Persevere with this treatment, with the assistance of other persons, for several hours, or until some of the more certain signs of death have made their appearance. (See p. 208 *et seq.*)

DEATH BY HANGING.

Death by hanging is of common occurrence. In the five years 1852-56, 494 persons perished in this way, in England and Wales, of whom 384 were males and 110 females. Of the 494 deaths by hanging no fewer than 451 were ascertained suicidal acts, of which 349 were by men and 102 by women. Judicial executions account for 7 of the deaths, so that only 487 were voluntary acts, of which 451 were

suicidal. In the whole five years only one death of a child under five years old was set down as an act of homicide. It is probable that all the other cases were suicidal.

As the cause of death is the same in hanging, strangulation, and suffocation, it may be well to make a few preliminary observations on these modes of death, before proceeding to examine them separately.

Though, in common language, death from any of these three causes is due to *suffocation*, the term *suffocation* has in medico-legal language a meaning quite distinct from that of the other two. Whenever death is produced by any impediment to the respiration, which does not act by compressing the larynx or trachea, it is said to be due to *suffocation*. Thus a man is said to be suffocated if his mouth and nostrils are closed, or if the action of the muscles of respiration is prevented by mechanical pressure either on the chest or abdomen. Certain noxious gases, too, are said to destroy life by producing *suffocation*. The subject of suffocation, then, separates itself at once from those of suspension and strangulation, inasmuch as it includes all those cases of violent death in which the respiration is suspended, by causes other than pressure on the throat. Our attention, therefore, must be directed, in the first place, to death by suspension and strangulation, in both of which pressure is exercised on the *air-tube* and *throat*.

This pressure may be applied to any part of the throat, and not only so, but it may be applied to the same part in different ways and degrees. The most simple mode is by direct pressure on the trachea with the fingers. Here the cause of death is obvious; it is the same as in many cases of drowning; the same as in suffocation—viz. *apnœa (asphyxia)*. Death takes place in consequence of the mechanical hindrance to the respiration. But the cause of death is not so clear when the entire circumference of the neck is subject to compression; for in this case not only is the larynx or trachea subject to pressure but the blood-vessels also suffer. In some instances both the air-tubes and the vessels are implicated; in others the air-tubes suffer the chief compression and the vessels escape; in others, again, the air-tubes escape and the vessels suffer all the pressure. The respiration and circulation are most completely impeded when a cord is fixed round the lower part of the neck, so as to embrace the trachea, and the large vessels at their entrance into and exit from the chest; or when the cord is applied, or drawn by the weight of the body, beneath the lower jaw. Both functions are less interfered with when the cord is fixed directly over the larynx, as the projections of the os hyoides and thyroid cartilage in some degree defend the air-passage and blood-vessels from pressure.

Now this variation in the position of the ligature, and in the pressure which it exercises on the organs of respiration and circulation respectively, explains the difference in the length of time required to destroy life in all those cases in which death does not take place instantaneously from injury to the spinal cord. But the circumstance of the air-tubes and blood-vessels being, in all other cases, compressed simultaneously

gives rise to the question, whether the compression of the air-tube or of the blood-vessels is the immediate cause of death. Is death, in other words, produced by *apnœa*, or by *apoplexy*?

It was formerly the general belief that death was produced by *apoplexy*; and this opinion was not unreasonable; for it is well known that mere pressure with the fingers on the carotid arteries will cause sleep, by checking the supply of blood to the brain, and apoplexy is often brought on, in persons predisposed to that disease, by the pressure of a cravat impeding the return of blood through the veins. The possibility, therefore, of apoplexy being brought about by pressure on the large blood-vessels is not to be doubted; but the question still recurs—in those cases of suspension or strangulation in which the air-tube and blood-vessels are simultaneously compressed to which of the two pressures is death to be attributed? Both causes doubtless combine to produce the fatal result, but there is every reason to regard the stoppage of the respiration as the essential cause; for death by apnœa would be much more speedily and certainly induced by a complete or partial stoppage of the breathing, than fatal apoplexy by the complete or partial arrest of the circulation. But an appeal may be made to actual experiment for the decision of this question. A dog was suspended by the neck with a cord, an opening having been previously made in the trachea below the place where the cord was applied. After hanging for about three quarters of an hour, during which time the circulation and the breathing went on as usual, the animal was cut down, and did not appear to have suffered materially. The cord was then shifted from above to below the opening into the trachea, so as to stop the ingress of air into the lungs; and the animal being again suspended, was in a few minutes completely dead.* In this experiment the compression of the vessels was probably less than it would be in many cases of death from hanging in the human subject, in which the violence employed, the height of the fall, and the weight of the body combine to tighten the cord, and thus exercise the strongest pressure on the vessels as well as on the air-tube.

A similar operation on the human subject is described by Smith ('Forensic Medicine,' Appendix, p. 561.)

"A man of the name of Gordon was executed at Tyburn, in April, 1733. Mr. Chovet having, by frequent experiments on dogs, discovered that opening the windpipe would prevent the fatal consequences of the halter, undertook to save Gordon, and accordingly made an incision in his windpipe, the effect of which was, that when Gordon stopped his mouth, nostrils, and ears, for some time, air enough came through the opening to allow of the continuance of life. When hanged, he was observed to be alive after all the rest were dead; and when he had hung three quarters of an hour, being carried to a house in the Tyburn road, he opened his mouth several times and

* 'Cyclopædia of Practical Medicine,' Asphyxia.

groaned; and a vein being opened he bled freely. No further attempts succeeded in eliciting any other signs of life. The want of success probably was to be attributed to the great weight of the man, by which the compression of the vessels of the neck must have become more effectual than in ordinary cases, and perhaps at the same time the opening into the trachea was not sufficiently free." It is obvious that the same results would happen if for the compression of the neck brought about in suspension by the weight of the body, an equal pressure were exercised directly by strangulation.

It appears, then, that when the windpipe as well as the large blood-vessels suffer compression, death may be attributed to apnœa; when the respiration is free, or but slightly affected, pressure on the vessels may cause death by apoplexy, but more slowly; and that when respiration and circulation are both impeded, both may contribute to the fatal result, though the stoppage of the respiration is the more efficient.

It has been suggested that the immediate cause of death in hanging and strangulation is pressure on the nerves which are subordinate to the function of respiration; but as such pressure does not prove fatal till the lapse of many hours, this explanation may be rejected.

Having now examined the questions which are common to death by hanging and by strangulation, the subject of death by hanging may be resumed.

Death takes place very suddenly in certain cases of suspension. This may arise from two causes: from fear producing syncope as in some cases of drowning; and from injury to the spinal cord by luxation of the cervical vertebræ, fracture of the odontoid process, or rupture of the intervertebral substance.

These injuries to the spine are caused either by the fall of the body from a great height, or from a rotatory motion given to the body at the moment of the fall.

Death after hanging takes place, then, in different ways and different intervals of time. When it occurs most promptly it may be referred to injury sustained by the spinal marrow above the origin of the nerves of respiration, and more rarely to syncope from fright. Next in point of rapidity will be the death from *apnœa*, and the least rapid that by apoplexy.

We are not without information as to the sensations that accompany death by hanging. Suicides who have been saved from death, and philosophers who have instituted experiments on themselves, have both contributed something to our knowledge. It appears that these sensations are not always the same; and the difference probably depends on the various degrees in which the windpipe and blood-vessels are compressed. Some have retained no recollection of what happened to them; others were conscious of sudden loss of sense and motion; in others a deep sleep was ushered in by flashes of light, by a bluish flame, by brilliant circles of colours, or by ocular illusions of a more

definite kind, accompanied by hissing or singing in the ears. In other instances, again, the sensations are stated to have been extremely pleasurable, though of short duration.

These sensations resemble those that occur in cases of disordered cerebral circulation, and those that precede the fits in some cases of epilepsy.

But it is only in cases of suicidal hanging that these pleasurable sensations manifest themselves. In homicidal cases, when much violence is used, the countenance expresses suffering; the eyes are brilliant and staring, and seem to be bursting from their sockets; and the eyelids open and injected; the tongue, swollen and livid, is forced against the teeth, or more or less protruded from the mouth, and compressed or torn by the contracted jaws; the lips are swollen and the mouth distorted; and blood, or a bloody froth, hangs about the mouth and nostrils; the upper extremities are stiff, the hands livid, and the fingers so forcibly closed on the palm as to force the nails into the flesh; and the convulsions are so violent as even to cause the expulsion of the contents of the bowels, and to produce erection of the penis, with expulsion of the urine, semen, or prostatic fluid. The circumscribed rosy or violet discolourations on the trunk and extremities common to all cases of death by apnœa are strongly developed; the course of the cord is distinctly indicated by some of the appearances presently to be described, but generally assumes the form of a well-marked bruise; and, on cutting through the skin, the muscles and ligaments of the windpipe are found stretched, bruised, or torn.

The internal appearances are the same as in other forms of apnœa. The lungs are said to be sometimes distended with air, sometimes collapsed.

The great difference in the two forms of hanging (suicidal and homicidal) is important; for it explains the very different appearances discovered after death in the two cases respectively.

Two principal medico-legal questions arise in regard to persons found hanged. 1. Did the suspension take place during life, or after death? and, 2, Was the hanging accidental, suicidal, or homicidal?

1. *Did the suspension take place during life, or after death?*

The points most worthy of attention as bearing on the solution of this question are:—The mark of the cord; The appearance of the countenance; The position and state of the tongue; The condition of the genital organs; and the expulsion of the fæces.

The Mark of the Cord.—It is now well ascertained that the appearances on the neck due to suspension during life are by no means uniform. In homicidal cases attended by violence, and involving strong struggles, the neck sustains great injury, marked by the bruised appearance of the skin, and the torn state of the subjacent parts; but in judicial and suicidal hanging much less injury is done both to the surface and to the deeper-seated parts.

In those cases (both judicial and suicidal), in which the position of

the cord is mainly determined by the weight of the body, it follows pretty closely the line of the jaw-bone, and there is an oblique indented mark, of the colour of a recent bruise, on the fore part of the neck, and yellowish brown, as if from a superficial burn, towards the angle of the jaw. Sometimes the bruise corresponds with the whole breadth of the ligature; at others there is a deep groove, bordered by two discoloured lines. The mark varies with the size of the cord and the materials of which it consists, being less distinct when a soft material, such as a handkerchief, is used, than when a hard ligature, such as a rope, is employed. When the material is hard and resisting, the appearances on the neck indicate the number of times that the ligature has been passed round it, and even the material of which it consists. But in many cases of judicial and suicidal hanging, the mark of the rope consists at first of a simple depression without any change of colour, oblique if due to the weight of the body, horizontal if firmly fixed round the neck. After the lapse of several hours, the rope-mark assumes a light-brownish tint. If an incision be made into the skin the cellular membrane is found strongly compressed, so as to form a shining white band. The appearances of a bruise are never developed at all. The countenance, as will be presently more fully stated, is at first pale and its expression natural, and it is not till several hours have elapsed that it assumes a livid tint, and still longer before it wears a bloated appearance.

In a case of judicial hanging, in which the cord was removed soon after the body had been cut down, I observed merely a depressed circle on the fore part of the neck, and a slight excoriation, with a burnt appearance over the angle of the jaw. In a case of suicidal hanging with a small rope tied firmly round the neck, which was removed without delay, there was a white depressed line deeper at the back of the neck than in front and assuming a dusky hue after the lapse of several hours. The strands of the rope were distinctly marked, but there was no ecchymosis on any part of the neck.

The appearances, then, produced by the cord in cases of hanging during life are not the same in all instances: in some cases there is the usual appearance of a bruise or ecchymosis; in others there is merely an indentation of the skin, without discolouration, and a condensed state of the subcutaneous tissues, resembling old parchment; and these appearances may be combined at the angle of the jaw, or in other parts of the neck, with slight excoriations, or appearances like those produced by superficial burns.

As the condensed, abraded, and burnt appearance of the skin may obviously be produced after death as well as during life, there remains only to consider as possible proof of death by hanging the value of the bruise or ecchymosis present in a certain proportion of the cases.

The question, whether *the appearances occasioned by the cord in an individual suspended during life, can be produced after death?* has been answered in the affirmative. In the chapter on Wounds and

Mechanical Injuries, it will be shown, when speaking of the distinction between bruises inflicted during life and after death, that ecchymosis may be produced for some time after life is extinct. The rule which applies to bruises in general will of course hold good with respect to this particular form of bruise; and accordingly Orfila proved, by experiments on the dead body, that, up to eighteen hours after death, precisely the same appearances may be produced as in suspension during life; Devergie has produced the parchment-like condition of the skin and subjacent cellular tissue, as well as the ecchymosed appearance bounding the depression; and Dr. Casper, of Berlin, succeeded up to two hours after death in producing ecchymosis resembling that occurring in hanging during life. It follows, then, that neither ecchymosis, nor the peculiar parchment-like condensation of the skin is a sure sign of suspension during life; and that consequently the appearance of the neck, taken alone, is not conclusive as to the question under consideration. But a very considerable effusion of blood, a rupture of the trachea, a separation of its cartilages, a dislocation of the spine, a division of the coats of the vessels, or, indeed, any evidence of great violence would furnish a strong probability of suspension during life, or of suspension after strangulation, for it is highly improbable that much force would be used in suspending a body which had been previously deprived of life by other means.

State of the Countenance.—In death by hanging, whether judicial or suicidal, the countenance is usually pale, and the expression of the features natural. But this pallor of the face is followed, after a few hours, by a livid hue of the lips, eyelids, and face generally; and, after a still longer interval, by a marked congestion of the countenance. There is nothing in the expression or colour of the face to show that suspension took place during life or after death; but if the vessels of the head and face were found highly congested in a body recently cut down, it would furnish a probability in favour of suspension during life; for, suspension after death, though it might produce discolouration of the neck itself, could not cause turgescence of the vessels of the head and face.

Position and State of the Tongue.—The same injected state of the base of the tongue, with swelling and protrusion of the organ, which occurs in other forms of death by apnœa, occurs also in death by hanging, and affords a strong probability of suspension during life.

State of the Genital Organs.—The genital organs of both sexes are affected in death by hanging. In the female, redness of the labia and discharge of blood have been occasionally noted, and in the male a more or less complete state of erection of the penis, with discharge of urine, of mucus, or of the prostatic fluid, is a frequent occurrence. It may be expected to be present in at least one case in three. But it must be borne in mind, that these appearances in the genital organs, when they do occur, are not characteristic of death by hanging or strangulation, for they have been observed in other forms of violent

and sudden death, as in fatal gun-shot wounds of the brain, and of the large vessels, and in poisoning by prussic acid. It is probable that the fluid ejected from the urethra is not semen but mucus; for, in the report of the case of a criminal executed in America, ('American Journal of the Medical Sciences,' May 1840,) there was no priapism, but a fluid was discharged which is stated not to have contained any seminal animalcules.

This sign then, when present, is one of considerable importance, for it is strictly vital, and affords a sure proof of violent and sudden death; and if combined with other external signs of death by hanging, and characteristic internal appearances, would be nearly conclusive. On the other hand, the absence of erection and emission is no evidence that death was not due to this cause.

Expulsion of the fæces.—The contents of the bowels are expelled in about one fourth of the cases of death by hanging; but as this also happens in other forms of sudden or violent death, it is to be regarded as evidence of such mode of death, but not of death by hanging only.

2. *Was the Hanging accidental, suicidal, or homicidal?*—Accidental hanging is of rare occurrence. One case is given by Dr. Smith: it was that of a girl who was swinging in a brewhouse, and near the rope used by her for that purpose was another for drawing up slaughtered sheep. In the course of the exercise her head got through a noose of this second rope, by which she was pulled out of the swing, and kept suspended at a considerable height, until she died. Dr. Taylor also relates a case communicated to him by one of his pupils. A boy ten years old had been amusing himself by fastening a piece of plaid gown to a loop in a cord, which was suspended from a beam in the room. In the act of swinging he raised himself, and gave himself a turn, when the loop of rope suddenly caught him under the chin, and suspended him until life was extinct. A playmate was witness of the occurrence.

With the exception of a small number of cases of this class, in which the mode of death is obvious, the question under consideration is narrowed to this: *Was the Hanging suicidal or homicidal?* The figures given from the returns of the Registrar General show that the probability is always strongly in favour of suicide; and, for obvious reasons, hanging is a mode of death which a murderer is little likely to resort to. It presupposes a great disproportion of strength between the murderer and his victim, or a combination of two or three persons against one. In the figures just referred to, the solitary ascertained case of homicide in the five years 1852 to 1856, was committed on the person of an infant.

There would be nothing in the appearance of the body itself, beyond the marks of a severe struggle, to distinguish the homicidal from the suicidal act; but if a man were found suspended at a height from the ground which he could not by any possibility have reached, and with

no object near on which he could have mounted, we might reasonably conclude that he was suspended by another.

It was once supposed that a man found with the feet or some part of the body touching the ground was more likely to have been hanged by another than by himself; but careful observation has shown this to be an error, for suicides have been found in every imaginary position, and very many in such a posture that death must have been produced by strangulation, the suicide leaning forward so as to compress the windpipe.

A great many cases, in which the bodies of suicides were found placed in every possible attitude, are given, illustrated by engravings, in an interesting paper in the fifth volume of the 'Annales d'Hygiène.'

As in most of the cases in which the body touches the ground the cord would not be so put on the stretch as to give it its usual oblique position, there would be no difference between such cases and cases of strangulation, except, perhaps, that in the latter the mark would be more distinct, and would embrace a greater portion of the neck.

The marks of violent struggles on the clothes or person of the deceased, or of severe injuries, would justify a suspicion of homicide; but as severe and extensive injuries have been known to be produced by a suicide, and slighter injuries may take place accidentally, this criterion must be used with great caution.

It appears, then, that in death by hanging, the presumption is always strongly in favour of suicide, but that we can rarely have the means of converting this presumption into certainty, or even of adding materially to its force.

It may be well to add that cases are on record in which persons found suspended have been previously killed by strangulation or by other violence, as well as cases in which the true cause of death was poison.

DEATH BY STRANGULATION.

This mode of death is rare compared with death by hanging. It accounts for fifty deaths in the year, of which thirty-seven in males and thirteen in females. Only half of these deaths were ascertained to be suicidal; of which twenty in males and five in females. Homicide by strangulation, though much more common than by suspension, is of rare occurrence in grown-up persons, but common in infants.

Death by strangulation differs from death by hanging only in the fact that the body is not suspended; but some of the cases of suicidal hanging in which the body touches the ground might with equal propriety be set down to strangulation.

Strangulation may be effected either by the uniform pressure of a ligature round the neck, or by direct pressure on the windpipe. In rare instances the two are combined, some object being introduced into the folds of the ligature, and placed immediately over the windpipe.

From this distinction between death by hanging and death by strangulation, it follows that, as a general rule, the mark on the neck will differ in the two cases; being oblique and high in the neck in death by hanging, circular and low down in death by strangulation. From this general rule, however, those cases of hanging must be excepted in which the cord is firmly fixed round the neck, and those in which the body is not completely suspended, but touches the ground; and those rare cases of strangulation in which the ligature happens to be fixed somewhat obliquely. The mark in hanging, therefore, may happen to be circular, and that in strangulation more or less oblique. The introduction of a foreign body into the folds of the ligature would be indicated by the greater size and distinctness of the bruise over the windpipe.

Another difference between strangulation and hanging is, that in strangulation much more force is used; hence the mark on the neck will be more visible, and the injury to the subjacent parts more considerable; and this will be especially the case in homicidal strangulation, for the murderer generally uses more violence than is necessary to effect his purpose.

The same questions arise in respect of strangulation, as of hanging —viz., 1. Was death caused by strangulation? 2. Was the strangulation accidental, suicidal, or homicidal?

1. *Was Death caused by Strangulation?*—A cord applied a few hours after death would not produce that degree of ecchymosis which would result from the application of the cord during life; and the turgescence of the countenance, as well as the characteristic post-mortem appearances, would be wanting. It is only, therefore, in suicidal cases, and in the scarcely conceivable case of slight force being used by the murderer, or death taking place suddenly, from shock or syncope, that the appearances produced by a cord applied during life could resemble those due to its application after death. The same observations apply to direct pressure on the windpipe. As, moreover, hanging is known to be the more common suicidal act, the murderer is not likely to hide the real mode of death by simulated strangulation. It is much more probable that having strangled his victim, he should endeavour to conceal the real mode of death, by suspending the body or placing it in a position suggestive of suicide.

In the well-known case of Bartholomew Pourpre, the deceased was first strangled and then suspended, and the mark of the cord was found at the lower part of the neck, while the teeth knocked in, and the bloody mouth, showed the force which had been employed.

The murderers of Sir Edmondbury Godfrey, after strangling him near Somerset House with a twisted handkerchief applied with great force, concealed the body for a time, and then carried it to Islington, where they threw it into a ditch, passed his own sword through him, and laid his gloves and other articles of dress on the bank, so as to excite the belief that he had committed suicide.

The absence of blood from the wound, though the sword had passed through the heart, excited suspicion, which was fully confirmed by the discovery of a bruise, an inch broad, extending round the neck; and a fracture of the cervical vertebræ, which rendered the neck so flexible that it could be turned from one shoulder to the other. The face which during life was remarkably pale, was livid and suffused, and the eyes bloodshot.

2. *Was the Strangulation accidental, suicidal, or homicidal?*— That strangulation, like hanging, may take place accidentally, is proved by the following cases.

An ingenious young man having nearly lost the use of his arms was in the habit of moving a heavy weight by means of a cord attached to it and passed round his neck. One morning, shortly after having retired to his own room, his sister discovered him sitting in a chair apparently lifeless. He was found to be quite dead, with the cord twisted round his neck. On cutting the cord, the weight fell on the floor. There was little doubt that the deceased had attempted to move the weight in the usual way, but that it had slipped behind, and had compressed the trachea so as to produce strangulation. (Dr. Smith.)

In July, 1839, Elizabeth Kenchan, an extremely dissipated, drunken, and disorderly woman, went to bed intoxicated, with her bonnet on, and in the morning was found strangled in her bonnet strings. It appears that she fell out of bed, that her bonnet became fastened between the bedstead and the wall, and that she, being too drunk to loosen the strings, was consequently strangled.

These rare cases of accident would be easily known to be such by the position of the body and the circumstances of the case.

In a few cases, then, death by strangulation has been due to accident; but if we have convinced ourselves that death did not take place in this way, the question is narrowed, and assumes this shape:—

Was the Strangulation suicidal or homicidal? — Strangulation appears to be a suicidal act in about half the recorded cases. As it is difficult for a man to strangle himself by the pressure of his hands even with the aid of a ligature, some mechanical contrivance is usually resorted to. A case is related by Orfila, of a suicide who was found lying dead in his bed, with two cravats twisted several times round his neck. Dunlop relates the case of a Malay who used a small stick for the same purpose. In the year 1838 a Mr. Watson, aged 88, strangled himself by placing a poker through the tie of his handkerchief and twisting it round and round. In another instance, the handle of a pot was employed, and several similar examples have been put on record.

Strangulation by pressure of the hand on the trachea may be safely assumed to be homicidal, as in the following case. A trial for murder by strangulation took place at the Chester assizes, in April, 1835. The prisoner, who was a robust man, upon some slight provocation,

seized the deceased by the cravat, and pressed him firmly by the neck against a wall, until he was dead. On examining the body, the face was found to be livid and swollen, and the features distorted. There was also a considerable discolouration and depression on that part of the neck to which the pressure had been applied. The prisoner was seen to commit the crime, and the case was clearly proved against him, but he was acquitted on the ground of insanity.

It has been alleged that fatal pressure with the fingers on the windpipe might occur accidentally; but this may be safely pronounced to be impossible. An unsuccessful attempt to attribute death to this cause was made in the well-known case of Beddingfield.

In 1763, a man named Beddingfield was found dead in his bedroom, and the charge was laid against his wife and man-servant. The medical testimony was very unsatisfactory, as no dissection had taken place, but it was proved that there were marks about the neck resembling those of fingers. A contradictory account was, however, given of the number: one surgeon said a thumb and *three* fingers; the other, a thumb and *four fingers;* while another witness, who also saw the marks, at the inquest spoke of *two* only, "which looked as if the blood was set in the skin." The defence was, that the deceased had fallen out of bed, and was found lying on the floor on his face, with one hand round his neck. The discrepancies in the testimony, and the omission of dissection, might, however, have led to subsequent doubts, had not one of the condemned persons confessed that he had strangled Beddingfield in his sleep, by seizing his throat with his left hand; and that though the deceased struggled violently and made some noise, yet he soon accomplished his purpose.

The following is a case of homicidal strangulation by a foreign body introduced into the ligature.

Dr. Clench, a London physician, was called out of bed by two persons on the night of the 4th of January, 1692, to visit a sick friend. He entered a hackney coach with them, and drove about several streets in the city for an hour and a quarter. The two persons then left the coach, and sent the driver on an errand. When the coachman returned, he found Dr. Clench sitting on the bottom of the coach, against the front seat, with his head on the cushion. Thinking him in liquor, he shook him, but obtained no answer. He then called the watch, and they found him strangled by a coal wrapped in a handkerchief, and applied directly over the windpipe. The coachman had heard no noise while driving the carriage.

The appearances present in the body in cases of forcible strangulation may be inferred from the evidence of Mr. W. Wilson in the case of Hector M'Donald, tried and convicted of the culpable homicide of his wife, at Inverary, April 1857. There was an abrasion on each side of the windpipe, five abrasions on the left arm, three on the right arm: the skin on the front and sides of the neck, and on the upper part of the chest was blackened. On the throat there were the marks of a

thumb and three fingers. The bruises were such as to justify the belief that the throat had been grasped by the left hand, of which the wrist was pressed upon the chest, and that the right hand had grasped the left arm of the victim. The internal appearances were highly characteristic of death by apnœa. The substance and membranes of the brain were injected; the right side of the heart contained a quantity of dark fluid blood: the left side was nearly empty. The lungs also contained a quantity of dark fluid blood. All the internal viscera were healthy.

DEATH BY SUFFOCATION.

Under this head are comprised all cases of apnœa, not produced by direct pressure on the windpipe, with the exception of drowning, which has already been treated separately.

On an average of the five years 1852 to 1856, 708 deaths by suffocation occurred, of which 427 in males, and 281 in females. Of the whole number, 106 were infants killed by overlying, and about 180, also infants, were suffocated by bed-clothes. Fifty-seven, of whom the majority were young children, were suffocated by their food, 38 by gases, chiefly carbonic acid. Two suicides, five murders, and one manslaughter by suffocation are reported to have happened annually.

Suffocation may take place in many ways.

The mouth and nostrils may be stopped by accident or by force. A person in a state of helplessness, from whatever cause, may fall on the face and be suffocated by water or loose earth; and new-born children by the discharges, by the bed-clothes, or by being overlaid in bed. Murderers have also sometimes despatched their victims by this means.

Mechanical Pressure on the Chest.—This may occur from accident, as when a quantity of earth or rubbish falls upon a man; or as a homicidal act, combined with strangulation; the murderer pressing with his whole weight upon the body, and compressing the larynx or trachea with the hand. Sometimes suffocation is effected, as by Burke and Bishop, by compressing the chest and closing the mouth and nostrils at the same time.

Suffocation by pressure on the chest was also resorted to in barbarous times as a torture, and constituted part of the *peine forte et dure* of our ancient law.

A risk of accidental suffocation from pressure on the chest has sometimes been incurred in taking casts with plaster of Paris.

Persons have also been pressed to death in a crowd. On the 14th of June, 1837, no less than twenty-three persons lost their lives at the Champs de Mars in this way, death being due partly to suffocation and partly to severe injury to the chest.

Closure of the glottis.—This also may occur accidentally, as in the

57 cases mentioned above as having been suffocated by food. When this happens in adults they are usually in a state of intoxication, or in a fit. Thus Paris and Fonblanque quote the case of a patient who was seized, after a heavy meal of pork, with an epileptic fit, during which he died; when, upon opening the trachea, it was found to contain a quantity of animal matter, resembling the pork on which he had recently dined.

Among familiar examples of accidental suffocation may be cited the death of Anacreon, attributed to a grape-seed; and of Gilbert the poet from swallowing a piece of mutton. There is a case on record of suffocation caused by swallowing a bee in some honey; another in which death was caused by slaked lime getting into the larynx, and producing violent inflammation there. Tumours in the glottis have led to the same result.

Examples of suicidal suffocation are afforded by slaves who, both in ancient and modern times, are alleged to have swallowed their tongues. In other instances, some article of dress, such as a handkerchief has been swallowed, and one case of determined suicide was brought about by swallowing a cork bristling with sharp pins. The preparation is in the museum of King's College.

Suicidal suffocation by the vapours of charcoal ~~are~~ is not common in England but very frequent in France.

Suffocation is not a mode of death frequently resorted to by murderers. When the victims are young and vigorous adults, the force required is such as to reveal the cause of death by external marks and internal appearances; but where the body is very weak from any cause, as in the new-born infant, the old man, or the intoxicated, suffocation is not very difficult to effect, and, if unaccompanied by violence, might not betray itself by the state of the body externally or internally.

The post-mortem appearances present in well-marked cases of death by suffocation may be deduced from the account given by Dr. Ollivier of Angers, of the persons suffocated in the Champs de Mars. In all the twenty-three persons, without exception, the skin of the face and neck was of a uniform violet tint, spotted with blackish ecchymoses. In nine there was infiltration of blood under the conjunctiva of the eye; in four, sero-sanguineous froth running from the mouth and nostrils; in four, blood running from the nostrils; in three, blood flowing from the ears; in seven, fractures of the ribs; in two, females, fracture of the sternum. In sixteen bodies that were opened, the blood was black, diffluent, and filling all the large veins at the right side of the heart. The pulmonary tissue was mostly of a reddish brown, and in three quarters of each lung, posteriorly, there was a considerable accumulation of black and liquid blood; but there was no ecchymosis, either on the surface or in the substance of the lungs, except in one case. In all the cases in which there was infiltration of blood beneath the conjunctiva, and in those in which blood flowed from

the ears, the vessels of the pia mater and substance of the brain were gorged with blood.

In consequence of the comparatively slight injuries caused by suffocation, this mode of death was, previous to the passing of the Anatomy Act, selected by the murderers Burke and Bishop. Burke, with his female accomplice, Macdougall, was tried at Edinburgh in 1828, and Bishop, with Williams and May, in London, in 1831.

Burke destroyed the deceased, Margery Campbell, by sitting on her body, covering her mouth and nostrils with one hand, and applying the other forcibly under the chin.

Fifty-nine hours after death, the eyes were closed; the features were found composed, as in deep sleep, red, and somewhat swollen; the lips of a dark colour; and the conjunctivæ of the eyes much injected with blood. There was a little fluid blood on the left cheek, apparently from the nostrils; the tongue was not protruded or torn by the teeth, but there was a slight laceration on the inside of the upper lip opposite the left eye-tooth; the cuticle under the chin was much ruffled, and the surface of the true skin, when laid bare, was dry and brown; but there was no ecchymosis. The integuments, except on the face, were perfectly free from lividity. The joints were flaccid. There was no effusion of blood or laceration of the parts around the windpipe, and no injury of the cartilages, but the os hyoides and thyroid cartilage were further apart than usual, in consequence of the stretching of the interposed ligament. The following were the internal appearances: The membrane of the windpipe healthy, with here and there some tough mucus, not frothy, and a few points of blood between it and the membrane. The organs within the chest were perfectly natural; the lungs remarkably so, and unusually free of infiltration. The blood throughout the body was black and fluid, and accumulated in the large veins, and in the right cavities of the heart. The abdominal viscera, with the exception of incipient disease of the liver, were healthy. The brain also was quite healthy, and presented a little more turgescence of vessels than usual; and there were three extravasations of blood in the scalp, but without corresponding external bruise. There were some marks of violence on the limbs, considerable effusions of blood among the muscles of the neck, back, and loins, and on the sheath of the spinal cord. The posterior ligamentous connections between the third and fourth cervical vertebræ were torn. These injuries to the back were shown to have been occasioned after death by the forcible doubling up of the body. It should be added that a 'handful' of clotted blood was found near the body.

In the case of Carlo Ferrari, the victim of Bishop and Williams, the appearances from which suffocation might have been inferred were even less strongly marked. The face, it is true, was swollen and congested; the eyes blood-shot, and the lips tumid; but the lungs were quite healthy and not congested, the heart was contracted, and all its cavities quite empty. But these exceptional appearances were explained,

by the fact, that the murderers, after stupefying their victim with liquor, lowered his body into a well with the head downwards, taking care to keep his mouth below the level of the water. In this case, too, there was some extravasated blood under the scalp, among the muscles of the neck, and on the spinal cord. The fresh state of the body, the appearance of the countenance, and a wound upon the left temple combined to excite suspicion, and led to the committal and conviction of the murderers.

In both these cases death was certainly caused by suffocation, and yet the appearance of the bodies was not such as to lead at once to the conclusion that death had happened in this way. The medical examiners, in both cases, were inclined to ascribe the deaths to the injury done to the spine, which was afterwards proved to have been occasioned after death by the forcible doubling up of the bodies in packing them.

In allusion to the opinion expressed by some medical men, that the signs of suffocation are so strongly marked as of themselves to arrest attention, Dr. Christison observes:—"In the body of the woman Campbell, no person of skill, whose attention was pointedly excited by being told that from general circumstances murder was probable, but the manner of death unknown, could have failed to remark signs that would raise a suspicion of suffocation. But if his attention had not been roused; if, for example, he had examined it in the anatomical theatre of an hospital, without knowing that suspicions from general circumstances were entertained regarding it, he might have inspected it even minutely, and yet neglected the appearances in question. Nay, a person of skill and experience would have been more likely to do so than another, because every one who is conversant with pathological anatomy must be familiar with such or similar appearances, as arising from various natural diseases." Dr. Christison then draws attention to the close resemblance between the appearances present in the body of Campbell and those observed in the body of a man who died of dysentery, adding that the 'vascularity of the conjunctivæ, and the contusions on the legs made the only difference.' *

* 'Cases and Observations in Medical Jurisprudence. Ed. Med. and Surg. Journal,' vol. xxxi. p. 243. (1829.)

CHAPTER III.

WOUNDS AND MECHANICAL INJURIES.

In this Chapter it is proposed to treat of all injuries inflicted on the body by mechanical means, excepting the several forms of death by suffocation treated of in previous chapters, and injuries by fire, and by lightning, which are reserved for separate examination in succeeding ones.

All injuries, therefore, which one man inflicts upon another, whether by cutting or bruising instruments, by his own person, or by forcing him against an obstacle, will have to be considered under this head. For the punishment of all such injuries when maliciously inflicted, the statute law makes provision, no less than for stabbing, cutting, shooting, drowning, strangling, and suffocating, by the insertion of the words "or shall by any means whatever cause to any person any bodily injury dangerous to life."

In examining so large a subject as this of wounds, or mechanical injuries, methodical arrangement is especially necessary. The different kinds of mechanical injury will have to be separately considered, the questions common to all such injuries must be discussed, and the peculiar way in which they affect the more important organs of the economy must receive due attention.

Three kinds of mechanical injury will have to be separately examined:—wounds in the common acceptation of the term, gunshot wounds, and mechanical injuries not usually designated as "wounds."

The old surgical definition of a *wound** makes it to consist in a *solution* of *continuity.* Mechanical injuries, therefore, may be conveniently divided into such as are *without solution of continuity* and such as are *with solution of continuity.* The first will include, *contusions, concussions, simple fractures, dislocations,* and *sprains.* The second comprises *incisions, punctures,* and *lacerations, compound fractures,* and *gun-shot wounds.*

The two classes of injuries, whatever the parts which they affect,

* 'A wound is a solution of continuity in any part of the body suddenly made, by anything that cuts or tears, with a division of the skin.' 'By the word skin, I understand not only the external cutis, but also the inward membranes of the gullet, ventricle, guts, bladder, urethra, and womb, all of which are capable of wounds from sharp instruments, either swallowed or thrust into them.'—Richard Wiseman's 'Chirurgical Treatises,' book v., chap. i.

have some points common to all the forms of violence included in the class. Thus, almost all injuries affecting the deeper-seated parts of the body are accompanied by external traces of the violence which produced them, whether that violence caused a solution of continuity or not. Hence, in the greater number of cases we shall have traces of the injury on the *surface*, and on this account it will be necessary to examine minutely the subject of bruises and incisions involving the external parts of the body.

The arrangement which it will be convenient to adopt has now been sufficiently indicated. The whole subject will be best examined under the following heads:—1. The characters of contused wounds, and of injuries unaccompanied by solution of continuity. 2. The characters of incised wounds, and of those accompanied by a solution of continuity. 3. The characters of gun-shot wounds. 4. The detection of spots of blood on weapons and clothes. 5. The questions common to all forms of mechanical injury. 6. Wounds as they affect the several important organs of the economy.

1. THE CHARACTERS OF CONTUSED WOUNDS, AND OF INJURIES UNACCOMPANIED BY SOLUTION OF CONTINUITY.

A blow with a blunt instrument gives rise to an appearance on the surface familiarly known as a bruise, and, in scientific language, as an *ecchymosis*.

A bruise consists in a discolouration of the skin produced by extravasation of blood into the cellular membrane. The blood may be thrown out in the superficial or in the deep-seated parts. When thrown out in the superficial parts, and especially in the lax and yielding portions of the skin, the colour makes its appearance at once. When the effusion is deeper seated, days may elapse before any discolouration of the skin takes place, and then it is not blue, as in superficial parts, but of a violet, greenish, or yellowish hue; nor is it always immediately over the effusion of blood.

The colour is not developed to its full extent at once; but it continues to deepen for five or six hours. When blood ceases to flow from the broken vessels, serum is effused, and inflammation is set up, and in this manner the extent of the bruise is increased. The colour of the bruise also undergoes a change, and passes from deep blue through shades of green, yellow, and lemon colour. After a further interval, the effused fluids are absorbed, and the colours first fade and then wholly disappear.

If the parts have received great injury, the inflammation runs on to suppuration, and an abscess forms if the injury is deep, an ulcer if superficial. The change of colour begins at the circumference of the bruise, where the effused fluids are small in quantity, and travels inwards towards the centre, where the blood is in larger quantity, and where the deep blue colour often remains after the rest of the bruise

has completely changed its appearance. In bruises of any extent, and in those parts which contain much blood, coagula are formed.

The extent of the bruise, and the rapidity of the changes which it undergoes, will depend on a variety of circumstances, such as the force used, the size and character of the weapon, the age and constitution of the sufferer, the full or empty state of the vessels, and the tension or laxity of the skin.

As the form of a bruise is mainly determined by the shape of the weapon with which it is inflicted, it often furnishes of itself strong presumptive evidence against an accused party. Thus Starkie, in his 'Law of Evidence,' instances an attempt at murder in which the prosecutor, in his own defence, struck the assassin violently in the face with the key of the house-door. The bruise which followed corresponded precisely in shape to the wards of the key, and it was chiefly through this very singular and unexpected piece of evidence that the assassin was afterwards identified and brought to trial. The subjects of death by hanging, strangulation, and suffocation, furnish familiar examples of the correspondence of bruises with the cause that has produced them.

Though the seat of the discolourations which constitute a bruise, is, as has been stated, the cellular membrane, it is not confined to this, but involves more or less the substance of the true skin. Bruises are thus distinguished from cadaveric lividity. (See p. 213.) The amount of injury, and consequent extent of bruise inflicted by a blow, will also depend, as has just been stated, upon the condition of the parts involved in the injury. A boxer in training would scarcely be marked by a blow which would disfigure a person in an ordinary state of health, and in severe cases of scurvy the slightest touch will occasion a bruise closely resembling that produced in healthy persons by greater degrees of violence.

Blows, even when very severe, do not always produce marks of injury on the surface. Thus blows on the abdomen, severe enough to rupture the viscera, do not always bruise the skin, though they sometimes lead to the effusion of blood between the muscles. In order that the appearance of a bruise may be produced, it is necessary that there should be comparatively hard and unyielding parts beneath the skin; and, on the other hand, where we find severe injuries of the hard parts, such as fractures of bones, without any trace of bruises on the skin, we should be cautious how we attribute such injuries to the blows.

Can the Appearance of a Bruise be produced after Death?

This question is answered by the experiments of Dr. Christison, from which it appears, that, up to two hours after death, and, in rare cases, after three hours and a quarter, appearances may be produced more or less closely resembling bruises inflicted during life; blood is effused into the cellular membrane, on the surface of the cutis, and even into its substance; and the blood thus effused is found to coagulate.

Means of distinguishing Bruises inflicted during Life from those inflicted after Death.—In certain cases this distinction is easy. If there is much swelling, if there is *any* change of colour, or any sign of inflammation, the bruise must have been inflicted during life.

If on cutting into the bruise, the effusion of blood is found to be considerable, and the clots large, the presumption is strongly in favour of the bruise having been inflicted during life. So also if the cutis is discoloured from the effusion of blood into its texture. This is a valuable diagnostic mark, except in the case of bruises inflicted within a few minutes after death, when, judging from the analogy of incised wounds, we may expect the same appearances as in those produced during life.

The same effusion of blood, which, on the surface of the body, gives rise to the appearance of a bruise, may occur in the internal parts as the result of violence, and yet leave very slight traces on the surface, or none at all; and it is therefore important to ascertain whether such effusions of blood in deep-seated parts may take place after death as well as during life. This question may be safely answered in the affirmative. In the body of Margery Campbell, the victim of Burke, in addition to the signs of suffocation, described in the last chapter, there were marks of severe injury to the back, to which Dr. Christison was at first inclined to attribute her death. On examining the back, blood in a semi-fluid state was found under the trapezius muscle, near the inferior angle of the scapula, as also in the left lumbar region, but there was no corresponding bruise on the integuments. Blood was also found in the cervical and dorsal regions, especially in the former. The ligaments connecting the vertebræ posteriorly were ruptured, but there was no fracture. On the sheath of the spinal cord opposite to the rupture, there was a mass of semi-fluid black blood, about the thickness of a penny-piece, and one inch in diameter; from this a thin layer of the same kind of blood extended along the posterior surface of the sheath, as far down as the lowest dorsal vertebræ. The spinal cord was uninjured, and there was no blood under its sheath. Dr. Christison, by experiments on the dead body, was able to prove, that all these marks of violence might be produced as much as seventeen hours after death; for he succeeded in producing them by bending the head forcibly down upon the chest in a subject which was cold, and in which all the joints were stiff. In the body of Carlo Ferrari, a similar effusion of blood was discovered. Coagulated blood to the amount of five or six ounces was found extravasated among the deep-seated muscles of the neck, from the occiput to the last cervical vertebra. A large quantity of fluid blood was also found both in the upper and lower part of the spinal canal, exterior to the sheath of the cord. There was no appearance of injury either to the vertebræ or their ligaments; there was no blood within the sheath, and the cord was healthy. The confession of the criminals themselves showed that these injuries to the spine were produced after death. (Refer to pp. 253-4.)

The difficulty which in some cases exists in determining whether a bruise was inflicted during life or soon after death, will be greatly increased, if the body we are called upon to examine is in a state of putrefaction. For the effect of putrefaction is to exaggerate the appearances of injury, and to produce alterations of consistence and colour, which would make it very difficult indeed to answer this question satisfactorily. It should also be borne in mind that when putrefaction sets in, the pressure of the gases evolved in the putrefactive process on the large veins of the body may cause copious outpourings of blood through ruptured vessels. This was well shown in the body of a man who had died of apoplexy. The veins of both arms had been opened, but no blood had flowed during life. After death, however, an abundant outpouring of blood took place from the wounded vessels.

In a case, however, which occurred at Paris, the effusion of blood caused by strangulation was discovered as a black mass twenty years after death. But the cord was found round the neck, and removed all the difficulty which might otherwise have existed.

In respect to *fractures* the same observations apply, and in nearly the same degree, as to contusions affecting the surface of the body. There is every reason to believe, that a fracture produced within a short period after death, and one produced during life, but speedily followed by death, would present very nearly the same appearances. A fracture produced some time before death would be readily distinguished by the inflammation set up about it.

Fractures, from the very nature of the parts injured, may be detected long after death. Thus, in the body of Clarke, the victim of Eugene Aram, the fracture and indentation of the temporal bone were plainly distinguished on the exhumation of the skeleton after it had been buried thirteen years.

2. CHARACTERS OF INCISED WOUNDS, AND THOSE ACCOMPANIED WITH A SOLUTION OF CONTINUITY.

Under this head are comprised incised, punctured, and lacerated wounds. Gun-shot wounds will be treated of separately. It is to incised wounds, as being of most frequent occurrence, that the following observations chiefly apply.

The immediate and most obvious consequences of wounds with solution of continuity are hæmorrhage, and retraction of the edges of the wound: the more remote effect inflammation. In a recent incised wound, inflicted during life, there is copious hæmorrhage, the cellular tissue is filled with blood, there are coagula between the lips of the wound, and the edges are everted. After the lapse of from eighteen to twenty-four hours there are the signs of inflammation, increased redness, swelling, and effusion of coagulable lymph.

Copious hæmorrhage affords of itself a strong presumption in favour of a wound having been inflicted during life, especially if the body is

fresh. Scanty hæmorrhage, or the entire absence of it, as in the case of Sir Edmundbury Godfrey (p. 248), supplies an equally strong reason for attributing death to some other cause. Lacerated wounds, and severe gun-shot wounds, however, form an exception to this rule. In the well-known instance recorded by Cheselden of a man's arm torn off by a windmill, and in a case more recently reported by Mr. Bransby Cooper, there was little or no hæmorrhage. On the other hand, a very considerable amount of hæmorrhage may take place after death, and especially when putrefaction is set up, if any large vein happen to be wounded.

In the case of incised, as of contused wounds, it is important to determine whether the same appearances that exist in wounds inflicted during life may be produced after death.

Characters of Wounds produced after Death.—The experiments of Orfila on the dog have shown, that the appearances proper to incised wounds inflicted during life may be produced immediately after death; and the experiments of Dr. Alfred Taylor made on limbs recently removed by amputation, show to what degree the resemblance may be carried.

After ten minutes there was immediate considerable retraction of the skin, with protrusion of the adipose substance, and the escape of a small quantity of blood; and after the lapse of twenty-four hours, the edges were found red, bloody, and everted; the skin somewhat flaccid; a small quantity of blood escaped on separating the edges; no coagula were found adhering to the muscles; but at the bottom of the wound there were several loose coagula readily broken down by the finger.

After the same interval of ten minutes a second experiment was performed. In this instance the edges of the wound were but very slightly everted; scarcely any blood escaped; and twenty-four hours afterwards the edges of the incision were pale and perfectly collapsed, presenting none of the characters of a wound inflicted during life; and at the bottom of the wound there were a few coagula of blood.

Other experiments performed at a later period after the removal of the limbs gave rise to appearances less distinctly marked. When the wound was not made till two or three hours after the removal of the limb, a small quantity of liquid blood was effused, and no clots were found. The edges of an incised wound made twenty-four hours after death were yielding, inelastic, in close approximation, and free from any coagula of blood. Such are the characters of *incised* wounds inflicted after death.

Lacerated wounds combine the characters of incised and contused wounds, being accompanied with a less amount of hæmorrhage than the former, and some degree of the discolouration attending the latter. For these reasons the distinction between such wounds inflicted during life and after death is less easily made.

Punctured wounds are intermediate between incised and lacerated wounds, resembling the former when inflicted with a sharp instru-

ment, and being accompanied by profuse hæmorrhage; but when made with a blunt object, being more nearly allied to lacerated wounds, and productive of but little loss of blood. *Sword*-wounds, traversing the body, are marked by a large depressed orifice of entrance, and a small and raised orifice of exit.

3. CHARACTERS OF GUN-SHOT WOUNDS.

Gun-shot wounds belong to the class of contused or lacerated wounds; of contused wounds when the shot does not penetrate, of lacerated wounds when it enters or traverses the body. Such wounds, as Wiseman observes, are "the most complicate sort of wounds;" they combine "contusion, attrition, and dilaceration" in a high degree; they occasion "all sorts of fractures;" they introduce extraneous bodies; and they give rise to hæmorrhage, inflammation, erysipelas, gangrene, and sphacelus. The lips of a gun-shot wound are "livid or blackish;" they become the seat of inflammation and swelling; and "blisters frequently rise about them," containing "matter of a fœtid smell."

Gun-shot wounds produced by discharges close to the person are "burnt by the flame," and they may contain particles of unconsumed powder. If covered by clothes, the clothes also may be blackened or burnt. As a general rule gun-shot wounds, unless they injure some large vessel, do not give rise to much hæmorrhage; but the destruction of parts occasioned by the sloughing and suppuration that follow upon them often occasions profuse and fatal discharges of blood.

The bullet, shot, or wadding discharged from guns or pistols at short distances sometimes lodge in the body; in other cases they traverse it. When they lodge in the body they often furnish very conclusive evidence. The bullet may prove to have been cast in a mould, or the wadding to be formed by printed paper or other material, in the possession of the person who fired the shot. It may even happen that the composition of the bullet, or the mode of making it, is peculiar. In medico-legal cases, therefore, the contents of a gun-shot wound should be carefully examined, and, if necessary, preserved. When bullets discharged from fire-arms traverse the body, the apertures of entrance and exit should be carefully examined. The aperture of entrance is round and clean, that of exit less regular in shape and jagged. On entering the body "the bullet forces the flesh in with it, and the place by which it enters presently contracts closer; but its going out is more lax." The same difference of entrance and exit is seen in the clothes covering the wounded part. Bullets which strike the body obliquely produce a valvular wound.

Bullets which lodge in the body are often found to have been turned out of their direct course by coming in contact with a bone, or other firm resisting structure. Thus (to give examples occurring in the practice of Richard Wiseman) a bullet which entered the cheek has

been cut out from the back of the neck; a second, which entered the outside of the small of the leg, was found on the inside of the thigh above the knee; and a third, which entered the outside of the arm, was cut out below the scapula. In some cases, the bullet has struck the head or abdomen, and after traversing the half-circumference of the part, has been found to be lodged, or to have passed out at, the opposite point. But a bullet may not only be turned from its straight course by encountering resistance, and being diverted into a less resisting channel, but it may be split into two or more fragments by striking a bone. These fragments may either traverse the body or lodge in it. If they lodge, they may be found to have taken the same eccentric course as the undivided bullet in the cases just cited: if they traverse the body they may occasion more than one wound of exit resembling in character wounds of exit caused by a single bullet.

When the bullet takes a direct course through the body (that is to say, when it is not deflected) the character of the two apertures, coupled with the direction of the line which joins them, may furnish important information as to the position of the body at the time the wound was received. So also when a bullet, after traversing an obstacle external to the body, such as wooden palings, or windows, strikes a wall beyond, the line of flight, and spot from which the shot was fired, may be readily determined.

Small shot discharged quite close to the body, and striking it at right angles, may give rise to a round clean wound not easily distinguished from one caused by a bullet; but at the distance of a foot or more the shot are found to scatter more or less, and to occasion an irregular wound. At the distance of three feet the shot are so much scattered that it is not possible to confound the injury with one caused by a bullet. In this class of wounds, we may always expect some of the shot to lodge in the body, and when fired close, or within a short distance, there will be the same marks of burning on the skin and clothing.

Fire-arms loaded with wadding, and fired quite close to the body, or within a few inches, may produce severe penetrating wounds, and destroy life, and even at the distance of a foot may give rise to severe and extensive superficial injuries. The unconsumed powder, when fire-arms loaded only with powder are discharged close to the body, may produce the same injuries as small shot.

From what has been said above of the complicated character of gun-shot wounds, it is obvious that they are attended with great danger to life. They may prove fatal, immediately, or within a short interval, by shock or hæmorrhage, and after a longer interval, by secondary hæmorrhage, by erysipelas, by tetanus, or by the inflammation and extensive suppuration following on the death of the injured parts.

The usual medico-legal questions, such as the more or less dangerous character of the wound, the effect of the treatment adopted, and of

the subsequent conduct of the wounded person, on the issue of the injury, and the amount of locomotion possible after the injury, arise in gun-shot as in other wounds.

The question whether the wound was the result of *accident*, *suicide*, or *homicide* may also be raised respecting these in common with other wounds. As a general rule, accidental wounds, whether inflicted by the wounded person, in loading, or in the act of carrying a loaded piece, or by another person pointing at him a piece supposed not to be loaded, or walking or shooting in his company, have the characters of wounds caused by discharges near the person; but these characters they have in common with suicidal wounds. But suicidal wounds have the character which accidental wounds often, and homicidal wounds, sometimes, lack of being inflicted in front on the head or region of the heart. To this rule, however, some suicidal gun-shot wounds form an exception, inasmuch as the weapon is directed to the back of the head. As a general rule, too, the suicide fires only one shot; but to this rule, also, there are exceptions, for suicides have been known to fire two pistols, and even to resort to fire-arms after the failure of incised wounds. In some cases we are assisted by finding the suicide in a room secured from within, with the weapon still grasped in the hand, and, when the priming was of powder, with the hand stained by it.

Some advantage is occasionally derived from an examination of the gun or pistol. In all cases where the combustion of the gunpowder is imperfect, the finger introduced into the barrel is blackened by the unconsumed charcoal; and on examining the residue it is found to consist of this unconsumed charcoal mixed with sulphuret of potassium. But where the combustion is perfect the finger is not blackened, for the residue is white and consists of the sulphate and carbonate of potash. After an interval of some days, varying with the more or less amount of moisture in the atmosphere, the mixed residue of charcoal and sulphuret of potassium becomes converted into sulphate of potash, which after a still longer interval may be found blended with the rust of iron.

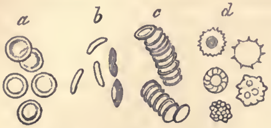
4. DETECTION OF SPOTS OF BLOOD.

The medical jurist may be required to examine red spots supposed to be caused by blood on wearing apparel, on cutting instruments, and on wooden floors or furniture; also, in some cases, to examine solutions of blood in water. He may also be required to distinguish human blood from the blood of animals.

Where spots of blood are recent, and the quantity of blood is considerable, the appearances which they present are highly characteristic, and there is no difficulty in obtaining a solution of a peculiar colour, readily distinguished from all other red fluids by its chemical and microscopical properties. But when the spots are not recent, and the quantity of blood is inconsiderable, the work of identification is less easy.

Blood is a compound fluid, consisting of fibrin, serum, and a colouring matter known as *hæmatosine*, which colouring matter is contained in the circular discs or red corpuscles figured in the annexed woodcut. The fibrin coagulates spontaneously; the serum is coagulated by heat or acids; the red corpuscles are visible under the higher powers of the microscope; and the colouring matter has some peculiar and characteristic chemical reactions.

Fig. 9.



Magnified 400 diameters.

The red corpuscles, or globules, of the blood are seen under the microscope as isolated discs, either *a* in plan, or *b* in profile; or *c* aggregated like piles of coin; or *d* variously contracted and crimped by the exudation of their contents.

The colouring matter of blood-stains is more or less completely dissolved out by *cold* water; and the *blood-solution* thus obtained has a vermilion red colour. This colour is discharged, and the solution changed to a dirty slate colour by boiling, at the same time that the serum is coagulated, and thrown down. This coagulum, if collected, dried, and boiled in *liquor potassæ* is completely dissolved, forming a dark-green solution. The blood-solution has also the characteristic property of not being changed in colour by the addition of a small quantity of *liquor ammoniæ*. With *infusion or tincture of galls* the blood-solution yields a red precipitate. These tests are quite characteristic. No other red solution has the same reactions. Those obtained from flowers and roots and the juices of fruits are changed to green or violet by liquor ammoniæ, and cochineal to crimson. The solution of *sulpho-cyanide of iron* yields a precipitate of oxide of iron, and is rendered colourless by zinc and sulphuric acid, and *permanganate of potash* is changed from pink to blue; and none of these colouring matters are coagulated and changed by heat. Red colouring matters due to the presence of salts of iron yield a dark-blue precipitate with the infusion or tincture of galls.

Blood-stains on articles of dress may be recognized by their consistence and colour, and more completely identified by microscopic examination. A spot of blood not disturbed by contact or friction feels like thick gum or starch. Small spots are circular, larger spots approach the circular form, and large and small alike have a defined and abrupt margin. Arterial blood has at first a rich red colour, and venous blood a purple hue. Venous blood first grows brighter by exposure to the air, but, after a time, in common with arterial blood, assumes a venous tint. After the lapse of a few hours, the blood, whether from an artery or vein, assumes a dusky blue colour, which it retains without change for years. Blood-stains on white calico upwards of twenty years' old have undergone no perceptible change.

The colouring matter of these stains may be procured for examination in the following manner. The stained fragment of cloth is to be cut out, placed in a test-tube with a small quantity of cold distilled water, and shaken for a few minutes. A recent stain so treated may yield a red, or reddish-brown solution, of a sufficient depth of colour to give characteristic results with liq. ammoniæ and on boiling. But older stains give up their colour very slowly and imperfectly, whether suspended in distilled water, as usually recommended, or agitated with water in a test-tube; and the process is not much hastened by separating the fibres of the cloth. For these older stains, therefore, a different process is required. The stain is to be moistened with a few drops of distilled water, and scraped with a scalpel or sharp knife. To the small quantity of coloured liquid thus obtained a drop or two of glycerine or syrup is to be added. The resulting liquid, placed on a glass slide and covered with a piece of microscopic glass, will be found to contain the red corpuscles figured at p. 264, mixed with a few fibres from the cloth. Stains on white calico upwards of twenty years old have yielded highly characteristic results when treated in this way.

Blood-stains on articles of linen or cotton may be shown to contain animal matter by placing them in a reduction-tube, applying the flame of a spirit-lamp, and exposing a moistened slip of turmeric paper to the gases which issue from the tube. The presence of ammonia is shown by the usual change of colour from yellow to brown. The colour and appearance of the stain, confirmed by this test, leave no room to doubt that the stain was caused by blood. This test is not applicable to silken or woollen textures.

Another, and very ingenious, test for blood-stains has been suggested and practised by my friend and colleague Professor Bloxam. It is founded upon the well-known fact that coagulated albumen becomes soluble in water at about the temperature of boiling oil (350° Fahr.). The stain is introduced into a strong tube of green glass sealed at one end, moistened by from half a drachm to a drachm of distilled water, and secured by sealing the open end of the tube. The tube, so sealed at either end as to bear strong pressure from within, is now placed in a small iron saucepan containing oil, which is kept boiling for the space of an hour, at the end of which time, the contents of the tube will be found to have acquired a dirty slate colour, and the stain to have parted with some of its colouring matter to the distilled water. The discoloured water, on being tested with nitric acid, bichloride of mercury, and ferrocyanide of potassium, will yield the white precipitates characteristic of the presence of albumen.

There is still another test for blood-stains recommended by Virchow as "one of the surest tests" as well as a most delicate one; and it is one of which he has practical experience in medico-legal cases. It is based on the production of minute crystals of *Hæmine*. The blood-stain is to be covered with dry, crystalline, powdered common salt,

moistened with glacial acetic acid, and evaporated at a boiling heat. The dry residue contains crystals of hæmine in large numbers. By this method Virchow was able to produce innumerable microscopic crystals from a blood-spot a line in diameter. These crystals are represented in fig. 10. The larger ones (1) are after Virchow, the smaller ones (2) are copied from the result of an experiment on aminute recent clot of sheep's blood. With blood-stains of long standing this test fails, though the stain on the glass is of a very characteristic colour.

Fig. 10.

300 diameters. 150 diameters.

Iron-moulds on linen have sometimes, as in a case related by Devergie, been mistaken for spots of blood; but the distinction is easily made. Cold water dissolves out the colouring matter of blood more or less quickly and completely; but it does not affect the iron-mould. Hydrochloric acid dissolves out the iron, which may be identified by its characteristic tests.

Blood-stains on floors and furniture may be identified in the manner just recommended. The stained portion of wood should be cut out, moistened with distilled water and scraped; or the small clot of blood may be carefully detached and placed in distilled water.

Blood-stains on articles of steel and iron are readily identified when they present themselves in the form of clots on a clean bright surface of metal. They are then of a clear red, or reddish-brown colour, are easily detached, and scale off when the metal is exposed to a moderate heat. The presence of animal matter in the spots is readily ascertained by heating them with the spirit lamp in a reduction-tube. Ammonia is given off, which is detected by its alkaline reaction on turmeric paper. A small particle of blood-crust is sufficient for this purpose. The crust placed in a few drops of distilled water will, after a time, yield a reddish-brown solution with the reactions already described; and if treated with syrup or glycerine, and placed under the microscope, will be found to contain blood-globules.

If the blood is merely smeared upon the instrument it will not scale off when heated; but it will be necessary to moisten the stain with distilled water, and scrape it off carefully for examination by tests or the microscope.

If the instrument has been for some time exposed to air and moisture, spots of rust will be mixed with those of blood. In this case, too, the stains are not detached by heat, and it will be necessary to scrape them off, place them in distilled water, and separate the insoluble particles of rust by filtration. The resulting coloured liquid will have the chemical and microscopic characters of the blood solution.

Two other kinds of spots on articles of steel or iron have been pointed out as liable to be mistaken for spots of blood, namely, spots of

rust and spots produced by lemon-juice, vinegar, or other vegetable acid.

Spots of Rust somewhat resemble blood-spots in colour, but they do not scale off on the application of heat, and they are not soluble in water. If thick enough to be detached, they are readily separated by filtration, leaving the water quite clear, and not affected by the tests for iron. A drop of hydrochloric acid placed on the spot of rust dissolves it, and leaves the metal clean, and on diluting the solution with distilled water, evidence of the existence of iron may be obtained by appropriate tests.

Spots of Lemon-juice have been mistaken for those of blood. A man, as in a case related by Orfila, was suspected of having murdered another, and a knife, apparently covered with blood, was found in his possession; but on submitting the knife to examination, it was found that the spots were due to citric acid. The instrument had been used some days before for cutting a lemon, and had been put by without being wiped.

The thinner spots produced in this way have a reddish-yellow colour. The thicker spots have a reddish-brown colour, nearly resembling that of blood, and they separate, like blood-spots, on the application of a moderate heat. When heated in a tube they give off a volatile matter, which has an *acid* reaction—spots of blood have an *alkaline* reaction. The solution in distilled water is *light yellow*—that of blood is *red*; it sometimes has an *acid* reaction—that of blood is *neutral*, or *faintly alkaline;* with infusion of galls it yields a *black* precipitate, a *blue* with ferrocyanate of potash, and a rich cherry red with the sulpho-cyanide of potassium. Blood yields a *red* precipitate with the first test, and is unaffected by the others. The oxide of iron is thrown down by alkalis.

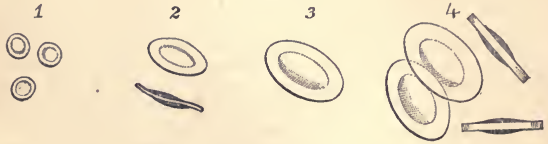
Supposing it to be clearly made out that the stain we have been examining is a blood-stain, two questions may arise: 1. Is it human blood, or that of an animal? 2. From what part of the body does the blood flow?

1. *Difference between the blood of man and that of animals.*—Two means of diagnosis have been proposed, the one microscopic, the other chemical.

Diagnosis by the microscope.—The only means of distinction under the microscope is afforded by certain well-known differences in the shape and size of the blood-corpuscles. The human blood-corpuscle, depicted in fig. 9, p. 264, is a circular flattened disc; and the blood corpuscle of mammals, with a single unimportant exception, has the same form. The only appreciable difference is in the size of the globules. In man they measure on an average $\frac{1}{3200}$ of an inch; in animals the diameters vary from $\frac{1}{3540}$ to $\frac{1}{6366}$. But these are only averages; and the extreme measurements which in man may be stated at $\frac{1}{2000}$ and $\frac{1}{4000}$, lie, in some animals, still wider apart. When it is borne in mind that, in most instances, we have to examine a blood-solution obtained from

dried blood, made to approximate to the average density of the blood by the addition of syrup, glycerine, or a saline solution; that the size of the globules is materially affected by the density of the medium in which they are seen; and that in the blood itself the diameter of one globule may be twice as great as that of another, it is not to be expected that the most skilful and practised person should be able to distinguish human blood from that of other mammals. But the blood-corpuscles of birds, reptiles, and fishes differ so widely in size and shape from those of man and animals, as to enable us to state positively that the blood in a given case is either that of a mammal, or belongs to one of the three classes of creatures just specified. The differences of size and shape in the human blood (1), the blood of the common fowl; (2), the blood of the frog; (3), and the blood of a fish, (4), are shown in the annexed engraving. The corpuscles are magnified about four hundred diameters.

Fig. 11.



(For some minute details of measurements in Mammalia, see 'Micrographic Dictionary,' Art. Blood; also Plate 40.)

Chemical Diagnosis.—It was Barruel who first proposed to distinguish the blood of different animals by the characteristic odour given off on the addition of sulphuric acid.

If sulphuric acid, diluted with half its bulk of water, is added to the blood of an animal, an odour is instantly perceived which certainly bears a close resemblance to the perspiration of the animal itself; and it is probable that the majority of persons would recognize the odour if informed of its existence. But it is certain that the majority would be mistaken if asked to name the animal which had supplied the blood.

I make this statement as the result of experiments made with fresh blood of different animals, in such quantity as one or two drachms at a time, in the class-room for several years in succession. The majority have always been wrong in their guesses. At the same time it should be stated, that, on one occasion, a member of my class was uniformly right in his opinion of several specimens of blood, though the experiment was so devised as to preclude mere guessing. As a means of distinguishing spots of blood, or solutions obtained from them, this test of odour must certainly be disallowed. It has also utterly failed in the hands of very competent persons.

Source of the blood.—In some cases the spots of blood submitted for

examination are found blended with hair, skin, fragments of mucous membrane, or epithelial cells; or with other matters adhering to the material upon which the blood has fallen. The discovery of such admixtures may often supply very important medico-legal information; but the subject is one of too great extent to be fully examined in this place. Such examinations as these should always be intrusted to persons having perfect knowledge of the microscope, and large experience in the use of the instrument.

5. THE QUESTIONS COMMON TO ALL FORMS OF MECHANICAL INJURY.

There are three questions common to all forms of mechanical injury; namely, 1. Was the injury inflicted during life? 2. Was it the cause of death? and 3. Was it accidental, suicidal, or homicidal? The first question has been already examined. The second and third questions still remain to be discussed.

Was the Wound the cause of Death?—The answer to this question rarely presents any difficulty when a man in the enjoyment of perfect health receives a severe injury, and dies soon after, before sufficient time has elapsed for disease to set in, or neglect, or unskilful treatment to prove injurious; before, in fact, any event has supervened to complicate the original question proposed. But when a considerable interval elapses between the receipt of the injury and the fatal event, such complications may arise, and render the answer to the question difficult.

The question—Was the wound the cause of death? may have to be decided in cases in which the fatal result follows soon after the receipt of the injury, as well as in cases in which the death happens at an interval so remote as to admit of the supervention of extraneous causes.

To the first class of cases belong the abnormal formation of the parts injured (as in the instance cited by Paris and Fonblanque, of the death of a boy caught robbing an orchard, caused by a blow intended as a simple chastisement on a skull preternaturally thin), and their abnormal situation (as in the familiar instances of an inguinal hernia, injured by a kick; of fatal hæmorrhage caused by a blow on the loins over the seat of a kidney containing a jagged calculus; and of a large abscess behind the ear ruptured by the same means).

To this class of cases also belong those sudden deaths which follow falls or blows too slight to account for the fatal result by the direct injury they occasion, death being really caused by the effusion of blood upon the brain, or the rupture of an aneurism; in both which cases it is possible to attribute the death to the excitement of the struggle as well as to the fall or blow. Also those cases of latent effusion on the brain or into the cavities of the chest which might prove suddenly fatal even in the absence of violence, but which might certainly cause death under the influence of excitement or shock.

In such cases as these the injury is inflicted in ignorance of the existence of any cause by which that injury, though comparatively slight, might be rendered mortal. To all other cases, such as those of young, feeble, or aged persons, and pregnant women, the English law, as laid down by Lord Hale, will apply: "It is sufficient to prove that the death of the party was *accelerated* by the malicious act of the prisoner, although the former laboured under a *mortal* disease at the time of the accident."

The second class of cases, or those in which an interval elapses before the wound proves mortal, comprises a greater number of special cases. Before treating of these cases in detail, it is necessary to premise that even when the interval between the injury and the fatal result is of considerable duration, it may be quite possible to attribute the death to the injury without any misgiving. The injury may be of such a kind that no strength of constitution, and no exercise of care and skill, could avert a fatal termination. In fractures or dislocations of the spine, for instance, and in gun-shot wounds when the bullet lodges in the body, however long the fatal result may be postponed, the death is fairly attributable to the injury alone. But though, in cases of this kind, no doubt can exist either respecting the true cause of death, or the guilt attaching to the act of violence, the lapse of time has, in most civilized countries, been taken into account, and by the common law of England, if the injured party survive one year and one day, the crime ceases to be murder, and English juries have sometimes shown a disposition to shorten this period very considerably.

Within this long period of 366 days there is ample opportunity for some of the circumstances now to be specified to come into play.

1. A trifling wound or injury may prove fatal, from the injured part taking on an unhealthy character, such as scrofulous inflammation, due to peculiarity of constitution, or from the supervention of some disease not necessarily or usually resulting from it, such as erysipelas.

2. To the same class of cases belong instances of fatal tetanus, or of delirium tremens from slight injuries, as well as rare instances of pyæmia from latent abscess brought into activity by a fall or blow, and instances of fatal diseases of internal organs springing up independent of the injury but soon after its occurrence.

3. Another circumstance bearing on the question, Was the wound the cause of death? is the improper management of the wounded party, whether consisting in the neglect of medical assistance, or of medical instructions, or in the resort to ignorant and unqualified practitioners, or in irregularities, misgovernment, and reckless exposure to cold, fatigue, or fresh injury, or to intoxication, on the part of the patient himself, or in *mala praxis* on the part of the medical attendant, being a qualified practitioner.

Was the wound accidental, suicidal, or homicidal?—Accidental death is a common occurrence in crowds, and in wrestlings and fights, when the deceased person falls, or is thrown or struck against,

hard resisting objects, in which case an examination of the spot on which the party fell will help to determine the question.

There is always a probability of accident when a body is found in a dangerous situation, as at the foot of a precipice, or in a river with steep banks; and the probability is increased when the deceased person is proved to have been drinking previously. In all doubtful cases the character of the injuries found on the body will go far to determine the class to which the death belongs. Bruises, fractures, and dislocations, for instance, are more consistent with the theory of death by accident than incised, punctured, or lacerated wounds.

If we suppose the alternative of accident to be excluded by the nature of the case, the original question is narrowed to this, *Was the injury suicidal or homicidal?*

As suicides are much more common than homicides, there is always a *primâ-facie* probability in favour of suicide, especially in middle-aged persons; but this probability will be materially modified by such considerations as, the place in which the body is found; the nature, situation, extent, and direction of the wound; and the number of wounds.

The Place where the Body is found.—If a corpse is found in a room with the windows and doors fastened on the inside, the circumstances are conclusive as to suicide. The absence of the instrument of death would be conclusive as to murder. So also, if the blood from a mortal wound has been washed from the body or floor, or the body itself has been placed in a position inconsistent with the mode of death, or covered, or buried.

The Nature of the Wound.—*Contused wounds* are rarely suicidal, though attempts at self-destruction by knocking the head against the wall are not uncommon. Severe contusions, therefore, are most probably homicidal, unless the body is lying near a height from which it might have fallen accidentally, or from which the deceased might have thrown himself. *Incised wounds* are as likely to be suicidal as homicidal, and it is not often that the peculiarity of the wound affords us any assistance in determining the class to which it ought to be referred. The cleanness and evenness of an incised wound have, indeed, been mentioned as affording a probability in favour of homicide. It is generally asserted, that a self-inflicted wound is likely to be jagged and uneven; but this assertion does not seem to be borne out by reasoning or by fact; for a suicide who has made up his mind is less likely to waver in his resolution than a man to remain still under the hands of a murderer; and some of the deepest and cleanest wounds of the throat are certainly suicidal.

But in some few instances the *shape* of an incised wound does afford very important aid in determining the question of suicide or homicide, by pointing out the kind of instrument with which the wound was inflicted, and the occupation of the murderer. Thus, a man found with his throat cut from within to without, as butchers slaughter

sheep, was found to have been murdered by a butcher. Orfila cites the case of a murder traced to a butcher by the fact of the body being found divided into two parts by a cutting instrument passed into the fibro-cartilage uniting the third and fourth lumbar vertebræ, and dividing the articulating processes of the vertebræ transversely through, as butchers are accustomed to cut through the spines of animals.

The Situation of the Wound.—It may be laid down as a general rule, that if a wound is so situated that the instrument of death, when placed in the hand of the deceased, cannot be made to reach it, whether by the motion of the hand itself, or by that of the part injured, or by both jointly, it was not self-inflicted. Wounds inflicted on concealed parts of the person, as within the labia, and beneath the breast of the female, are in all probability homicidal. It must, however, be borne in mind that while murderers sometimes inflict injuries of a kind to appear suicidal, many suicides are moved by very eccentric impulses.

The Extent of the Wound.—It has been thought that a suicide would not have courage or strength to inflict a very extensive wound upon himself; but experience is opposed to this view. Suicidal wounds of the throat, for instance, are usually deep and extensive; and in newspaper accounts of cases of suicide nothing is more common than to read of the head being nearly severed from the body. Superficial wounds of the throat are, however, among the most common forms of pretended suicide.

The Direction of the Wound.—Suicidal wounds generally pass from left to right, and from above to below, such being the most natural movement of the arm. In the case of left-handed persons, the direction would be from right to left. Wounds of the throat, whether suicidal or homicidal, are, however, generally transverse. When persons of different statures fight together, it is natural to suppose, that a wound inflicted by the taller man would pass from above downwards, and the reverse if given by the shorter, supposing both combatants to be in the erect posture. In wounds inflicted by a sword, or by fire-arms, it is always important to notice both the direction of the wound, and the orifices of entrance and exit.

The Number of Wounds.—The coexistence of several mortal wounds affords a presumption against suicide, but only a presumption; for after inflicting on themselves wounds necessarily mortal, suicides have retained strength and determination enough left to inflict others. Thus Orfila relates the case of a gentleman at Rouen who was found dead in his chamber, with two pistols lying in the room, one near the body, the other on the bed, at some distance from it. The deceased had shot himself in two places. One wound, apparently inflicted while he was lying on the bed, had completely traversed the left side of the chest, breaking a rib before and behind, perforating the lung through its middle portion, and passing near to the roots of the pulmonary veins. A very large quantity of blood was extravasated in the thorax.

After inflicting on himself this serious injury, the deceased must have risen from his bed, walked to a closet to procure another pistol, with which he produced a second wound that must have proved instantly mortal. The ball had entered at the frontal bone, and, after traversing the left hemisphere of the brain, had become lodged against the os occipitis. There was not the least doubt of this having been an act of deliberate suicide.

Mr. Watson gives a case of suicide in which no less than ten wounds were inflicted on the throat.

It is scarcely necessary to observe that most of the probabilities just established are liable to lead to error if too implicitly relied upon. In inquiring into the true manner of death in doubtful cases we have to guard against false inferences from circumstances purely accidental as well as from arrangements made to deceive us.

Nor will it always be safe to assume that a severe injury, actually inflicted by another, is the real cause of death; for as in a case related by Wildberg, a death occurring during a chastisement may, on examination, be found to have been due to poison.

The *circumstantial evidence* in death by wounds is of the first importance. It has been already alluded to under the head of persons found dead. Thus Sellis, a servant of the Duke of Cumberland, afterwards King of Hanover, was found lying dead on his bed with his throat cut, while his master was under the care of Sir Everard Home severely wounded in the head and hand. His Royal Highness stated that he was roused from sleep by a blow on the head, followed by several others, one of which caused an immense effusion of blood; that he leaped out of bed, and followed his assailant, who repeatedly struck at him, and would doubtless have murdered him, but that the doors protected his person from some of the blows. Every part of this statement was confirmed by the circumstantial evidence. The coloured drapery at the head of the duke's bed was sprinkled with blood; there were traces of blood on the passages and staircase, and on the doors of all the state apartments; and Sellis's coat was found hanging on a chair out of reach of blood from his bed, but the sleeve was sprinkled from the shoulder to the wrist "with blood, quite dry, and evidently from a wounded artery."

When Lord William Russell, the victim of Courvoisier, was found lying dead in his bed with his throat cut, the facts that the instrument of death did not lie near the body, and that a napkin was placed over the face, were in themselves conclusive as to the question of suicide or homicide; and left no doubt whatever that he had been barbarously murdered. Again, when a woman of the name of Norkott was found dead in her bed with her throat cut, the fact that, on the *left hand* of the deceased, there was a bloody mark of a *left hand* was conclusive evidence of her having perished by the hand of another.

In addition to the questions already examined there are others which may have to be considered. We may be asked whether a

given wound is dangerous to life, and of many wounds which was mortal. Sometimes, too, it may be important to know how long the wounded person survived the injury, and to fix the point of time at which a wound was inflicted. These questions will now be briefly discussed.

Is the Wound dangerous to Life?—This question is easily answered in the case of injuries to the large blood-vessels and important viscera of the body, but less easily in the case of injuries which affect life rather by their extent than by the importance of the parts implicated; for while, on the one hand, slight injuries to parts altogether unimportant may, in peculiar states of constitution, prove fatal, on the other hand, recovery may take place from injuries the most severe and extensive, as was the case of Mr. Tipper, who was pinned against a stable-door by the shaft of a gig traversing his chest.

The question of the danger attending wounds or injuries of the several important parts of the body will be found discussed under the next heading.

Of many Wounds which was mortal?—It is easy to understand how this question may become important in a medico-legal point of view. A mortal struggle may begin with blows and end with the use of a stabbing or cutting instrument, and the crime would have a very different aspect, according as the death was attributable to the blows or to the stabs or cuts. The question is of so general a nature that it must suffice to indicate its importance.

How long did the wounded person survive?—This question, too, may evidently assume importance in a court of law, especially in connexion with the amount of exertion possible after severe injuries. But the question, as one of detail, can be answered only as in the next division.

When was the Wound inflicted?—This question may arise either during life or after death.

During life the question must be answered, in the case of contused wounds, by the extent of the ecchymosis and the colours it assumes; in the cases of incised and punctured wounds, by the state of the divided parts, whether they are filled with extravasated blood or not; and whether the edges are swollen, and the surrounding skin inflamed.

After death the question either resolves itself into the simple inquiry, How long has the deceased been dead? or into the double question of the date of the death and the length of time that the deceased survived the injury. The presence or absence of animal heat, of cadaveric rigidity and of putrefaction, and the progress which putrefaction may have made, must be taken into account. These changes in the condition of the dead body take place, as has been already observed (p. 212), with very different degrees of rapidity in different subjects; so as to oblige us to speak of the time occupied by them with caution and reserve.

6. OF WOUNDS AS THEY AFFECT THE SEVERAL PARTS OF THE BODY.

Some of the questions which have been merely indicated as important in the previous division, will be examined in detail in this.

Wounds of the Head.—Injuries to the *scalp* are of more importance than those of the integuments of other parts of the body, partly on account of the peculiar tendency of the skin itself to take on the erysipelatous inflammation, partly from the quantity of loose areolar tissue which intervenes between the tendon of the occipito frontalis and the periosteum, and which is very liable to become the seat of diffuse inflammation; and partly from the relation of the tendon to this lax tissue, preventing, as it does, the escape of the effused products. Punctured wounds of the scalp are dangerous on account of the inflammation which they set up in this tissue, and the want of free exit for the discharges. Contused wounds are also dangerous for the same reasons. On the other hand, extensive lacerated wounds which do not involve the periosteum are rarely productive of serious consequences, inasmuch as they afford free passage to the products of inflammation.

Fractures of the Skull are not more important than those of other bones, unless they are accompanied by injury to the brain or its membranes. But in this case, as in that of wounds of the scalp, a slight injury may lead to fatal consequences, while complete recovery may take place after very extensive injury. The force that occasions the fracture may, at the same time, produce concussion, or other injury to the brain. It is important also to understand, that a blow does not always fracture the bone on which it alights, but that it may produce a counter fracture at an opposite part of the skull. A severe blow on the vertex of the head, for instance, will often occasion a fracture at the base of the skull, especially when applied at once to a large surface, as in a fall from a height.

In forming an estimate of the danger attending fractures of the skull, it is necessary to bear in mind the different thickness of its several parts. Thus, a blow on the temple would be productive of greater injury than one of equal force applied to other parts of the cranium. The orbitar plate is another part which by its extreme thinness exposes the brain to serious injury from thrusts with pointed instruments. The cribriform plate of the ethmoid bone again would be easily fractured, and the base of the brain be readily injured by a sharp-pointed instrument thrust up the nostril.

Injuries of the Brain itself will have to be considered under the distinct heads of concussion, compression, wounds, and inflammation.

Concussion of the Brain.—This is a common effect of severe blows or violent shocks. The symptoms often follow immediately on the accident, and death takes place without reaction, or any improvement

from the usual remedial means. In other cases the symptoms of concussion and compression are combined, and in others, again, concussion is followed by compression or inflammation.

Several cases of death by concussion are on record in which no lesion of the brain could be discovered. Thus, Mr. Travers, in his work on 'Constitutional Irritation,' gives the case of a prize-fighter who was taken off the ground insensible, and apparently apoplectic, and died in eight hours; yet no lesion or extravasation could be discovered on careful inspection of the brain.

The interval which elapses between the receipt of this form of injury, and the fatal termination is very various. It may prove fatal, as in the case just quoted, in a few hours, or after the lapse of several days, weeks, or even months. Thus Richard Wiseman, in his chapter on Wounds of the Head, gives the case of a lady who received a blow on the head while riding under a pent-house. The blow stunned her, and she died after many months of suffering from the injury with symptoms pointing to abscess of the brain.

It is a remarkable circumstance connected with this class of injuries, that the patient sometimes seems to suffer little or no immediate inconvenience; but, after the lapse of some days, is seized with symptoms of compression or of inflammation of the brain. Thus, Mr. Pott gives the case of a woman who received an injury on the head, and remained well for twelve days. She then fell ill, and died with symptoms of compression of the brain. The ventricles were found to contain bloody serum, and a small coagulum of blood. And Abercrombie gives the case of a girl, aged thirteen, who fell from a swing, and struck her head violently against the ground. For six weeks after the accident she complained of headache, but was not otherwise ill. Feverish symptoms then came on, followed by slight delirium and coma, and she died two months after the fall. The ventricles were found distended with serous fluid, without any other morbid appearance.

Compression of the Brain.—This may be caused by depressed bone, or by the effusion of blood or serum. The symptoms come on suddenly or gradually, according to the nature of the compressing cause, and the fatal result follows in varying intervals of time. In cases of compression produced by depressed bone, the cause of death is obvious, and can give rise to little difficulty; but when it arises from effusion of blood or serum following an injury, it is easy to allege that the effusion and consequent fatal result were due, not to the injury itself, but to some concomitant circumstance. Thus, if in the course of a struggle a man is thrown down or struck, and dies soon after, with symptoms of compression, and it appears that an effusion of blood has taken place, the effusion may be attributed to the excitement of the contest, and not to the injury itself; and the question will be even more difficult if the deceased was given to habits of intoxication, or was of a plethoric habit, and apoplectic make, or of an advanced age.

The inquiry will be still more difficult, if on dissection the vessels of the brain are found in a diseased state; but as effusion of blood rarely takes place *on the surface of the brain* from disease, the difficulty will only attach to effusions of blood at the base, in the ventricles, or into the substance of the organ.

Wounds of the Brain.—This class of injuries presents considerable difficulty in a medico-legal point of view—a difficulty which cannot be better set forth than in the words of Richard Wiseman. He says that "the greater symptoms that are usually said to attend the wounds of the brain do show themselves more uncertainly than a speculative chirurgeon would imagine; and in cuts and wounds made by sharp weapons or sudden strong force, more uncertainly than in contusions, concussions, and depressions of the skull; the highest of them, viz., vomiting, stupor, loss of spirits, with a paralysis of legs and arms, arising more suddenly in these latter cases than in the former." "Nay, we see many die suddenly from a box on the ear, and from small blows or wounds. In some whereof, upon opening the cranium, there hath been much blood extravasated: in others none at all, or aught else that may be thought to have killed the patient." "Others I have been called on to see opened, when there had preceded only a contusion of the calvaria, without any fissure, or more extravasated blood than is usually seen in every opening on taking off the cranium: yet the patient lay, as I am informed, under all those symptoms of delirium, coma, &c. Then, again, I have drest many that had been cut through the skull, the shivers of bones lying pasht with the flesh and hair upon the dura mater: yet the patient hath been without any symptoms of such a wound; which I suppose happened by reason of the bones lying loose upon the membrane."

Of severe symptoms speedily supervening from a slight injury the following is an example. A young man received a blow on the forehead from a cudgel, soon took to his bed and became delirious: a sopor followed, and after some days he died. A small hair-like fissure was found running from the great canthus of the eye upward. On removing the skull and dura mater but little blood was found extravasated, and the pia mater little altered. Of comparatively slight symptoms following very severe injuries, the following is an example of the opposite kind from the same author: A soldier was shot in the face by a case-shot, and had "his face, with his eyes, nose, mouth, and forepart of the jaws, with the chin shot away, and the remaining parts of them driven in. One part of the jaw hung down by his throat, and the other part pushed into it. I saw the brain working out underneath the lacerated scalp on both sides between his eyes and brows." Yet this man, after being carried off as dead, was found next morning knocking against the door of the room in which he had been placed, and was seen standing by the door. He was quite sensible, implored help by signs, and assisted himself to drink. His wounds were dressed, and he remained under Wiseman's care six or

seven days, being left alive at the end of that time. An equally remarkable case, illustrating the power of locomotion that may remain after very severe injuries of the brain, is related in the voyages of the great French surgeon, Ambrose Paré. "A soldier in my presence gave to one of his fellows a stroke with an halbard upon the head, penetrating even to the left ventricle of the brain, without falling to the ground." After being dressed by Paré "he returned all alone to his lodgings, which was at least 200 paces distant." The third day he came staggering to Paré's tent to be dressed, but died under his hands in a convulsion. Paré says: "I have recited this history as a monstrous thing, that the soldier fell not to the ground when he had received this great stroke, and was in good senses even till death."

Other remarkable cases of the same kind are to be found in the works both of Paré and Wiseman. Many modern cases might also be cited, but the following will suffice. Thomas Fothergill was charged before Mr. Justice Willes at Newcastle with the wilful murder of John Smith. The prisoner struck the deceased on the head with a pickaxe. The blow knocked him down, and then the prisoner struck him again with the pickaxe on the body. The deceased was lifted up by a fellow-workman, and after a time was able to walk to his lodgings, from which he was conducted to the Newcastle Infirmary, where he died ten days afterwards of the injuries he had received. On examination it appeared that he had received a wound on the temporal bone, which had driven it in and had lacerated the brain; and the spleen was also found to be torn by external injury. Either injury was sufficient to cause death.

Inflammation of the Brain.—Inflammation of the brain may follow upon injuries, not only to the organ itself, but to the scalp, and the parts most nearly connected with the brain, such as the orbit and ear. The severity of the inflammation is not always proportioned to the injury received. A slight injury may give rise to very severe inflammation, a severe injury to very slight effects. The period at which inflammation sets in is also very variable. As a general rule, it does not follow directly upon the injury, but several hours, some days, or even weeks may elapse before it takes place.

Injuries of the head, then, have this peculiarity, that at first they often appear of little consequence, but after a considerable interval dangerous symptoms may arise and prove fatal. Railway accidents have more than once given rise to difficult questions relating to this class of injuries. The symptoms of injury to the nervous system have not shown themselves at once, but the following day, or after a still longer interval, and much difficulty has been experienced by the jury in awarding damages, in consequence of conflicting medical opinions. In the interval which elapses between the receipt of the injury and the accession of dangerous symptoms, there is always room for neglect or mismanagement, on the part of the patient, his friends, or the medical

attendant, which may materially affect the question,—Was the injury the cause of death? This question, therefore, has a peculiar application to injuries of the head.

Injuries to the Spinal Cord.—The spinal cord, like the brain itself, is subject to concussion; to compression, from effusion of blood on its surface or in its substance; and to wounds from fractured vertebræ. Concussion and compression may follow severe shocks, as in railway accidents; the more severe injuries arise from falls or blows, or sudden twisting movements of the neck. Injuries to the substance of the cord generally prove fatal, the interval varying according to the degree of violence used and the part of the spine which has been wounded. Serious injury to the upper part of the cord proves immediately or speedily fatal by paralyzing the muscles of respiration; injuries to the cord opposite the lower cervical vertebræ (the fourth, fifth, sixth, and seventh) prove fatal in from four or five hours to as many weeks or months: in rare instances not till the lapse of years. In the case of John Carter of Coggeshill in Essex, displacement of the last three vertebræ with pressure on the cord opposite the seventh vertebra, did not prove fatal for fourteen years. When the cord is injured in the dorsal or lumbar region there is loss of power and sensation in the parts below the seat of injury with retention of urine and loss of power in the sphincter ani, requiring constant medical aid and careful nursing. With these aids life may be prolonged for years. Many injuries to the brain principally affect its base, and by causing pressure on the medulla oblongata impair the functions of the nerves supplying the muscles of respiration.*

Wounds of the Face.—These injuries obviously produce great disfigurement, and, in consequence of the large distribution of important nerves over the face, still more grave inconvenience. From the near proximity of the principal features to the brain, there is also a risk of injury to that organ, as well as of inflammation extending from the seat of the wound. In this respect the wounds of the integuments of the face rank next in importance to those affecting the scalp.

Wounds of the Throat.—These injuries are important from their frequency. They are the chosen mode of death with a great majority of suicides, and sometimes a murderer inflicts a wound on the same part in the hope that his victim will be supposed to have committed suicide. The degree of danger depends upon the position and the parts implicated. Wounds of the anterior part of the throat are less dangerous than those of the side of the neck; those of the lower part of the throat, less so than those of the upper part. A division of the carotid artery is almost necessarily fatal, and that of the internal

* For a group of cases of injury to the cervical portion of the spinal cord, consult 'Lancet,' July 19, 1856, p. 85. See also 'On Concussion of the Spine,' a clinical lecture by Mr. Skey, 'Lancet,' Jan. 10, 1857.

jugular vein is attended with great danger from hæmorrhage, and from the introduction of air into the circulation as well as from the risk of phlebitis. Wounds of the larynx or trachea are attended with comparatively little danger, and those of the trachea are less important than those of the larynx.

The question, Was the wound the cause of death ? is easily answered, but the question, Was the wound suicidal or homicidal? is less easy of solution. There is also a question of considerable interest relating to wounds of the throat, namely, What amount of voluntary motion is possible after the receipt of a severe wound?

The questions of suicide or homicide, and of the amount of voluntary motion possible after a severe wound in the throat, were raised in the case of Captain Wright, who shared the captivity of Sir Sidney Smith in France, and his celebrated escape from the Temple, and who had the misfortune to be taken a second time and imprisoned in the same place. He was found dead in his bed with his throat cut, and the razor closed in his right hand. There was an extensive transverse wound on the anterior and superior parts of the throat, above the bone of the windpipe, cutting through the skin, the muscles, the windpipe, the œsophagus, and the blood-vessels, and penetrating to the cervical vertebræ.

The circumstances of the case are involved in so much mystery that it is impossible to determine by the evidence collected with great pains by Sir Sidney Smith, whether Wright really committed suicide or not. But it is easy to show that the mere fact of the deceased being found with the razor closed in his hand does not militate very strongly against the supposition of suicide; for, in the case of the suicide of a military officer, which occurred in September, 1838, the head was found nearly severed from the body, and there was no room to doubt the fact of suicide, yet the razor did not fall from the hand, but was placed upon the dressing-table. In a more recent case, a madman, after inflicting a severe wound on his throat had time to struggle with the maid-servant before he fell down dead. In October, 1833, a man cut his throat with a razor while walking along Oxford Street. He divided the carotid artery and several of its branches, the jugular vein of one side, and the trachea; yet after inflicting the wound he was seen to hold a handkerchief to his neck, and run forwards. He fell dead on the pavement, about four yards from the spot where he wounded himself. The razor was found firmly grasped in his hand.

In the remarkable case of Mary Green, who was murdered in 1832 by John Danks, the confession of the culprit, and the circumstantial evidence coincided to prove that, after a wound which divided *the trunk of the carotid artery, and all the principal branches of the external carotid, with the jugulars*, the female must have risen from the ground, run a distance of *twenty-three yards*, and climbed over a low gate. From actual trial it appeared that it must have taken at least

from fifteen to twenty seconds to run from the spot on which the murder was committed to that on which the body was found.*

Wounds of the Chest.—Incised wounds of the parietes of the chest are not attended with any peculiar danger, but severe contused wounds by causing fracture of the bones, and consequent injury of the internal parts, often prove fatal. The fatal result is due either to extensive rupture of the viscera, to hæmorrhage, or to inflammation. Severe contusions of the chest may also terminate fatally by the shock which they occasion. This class of injuries is of common occurrence in prize-fights, in falls from great heights, and from heavy objects crushing the chest. Penetrating wounds of the chest are dangerous, inasmuch as they can scarcely fail to injure some important organ, occasioning thereby fatal hæmorrhage or severe subsequent inflammation; but cases are recorded of sword and gun-shot wounds traversing the chest, and yet occasioning no bad symptoms, and terminating favourably; and the majority of cases of injury to the chest which were under Wiseman's care after the battle of Dunbar seem to have recovered.

Wounds of the Lungs.—Hæmorrhage is the immediate consequence of this class of injuries. The blood may be discharged by the wound, or by expectoration, or it may accumulate in the cavity of the pleura, causing great difficulty of breathing. When the large vessels are wounded the hæmorrhage is copious and speedily fatal. An injury to the substance of the lung itself is not necessarily fatal, for patients have recovered after removal of a portion of the lung, and, in rare instances, foreign bodies, such as bullets, have remained in the lung for years, and have been inclosed in a cyst. Inflammation is a common consequence of wounds of the lung, especially when a foreign substance has been forced into the wound, as happens in injuries with fire-arms. Cases of wounds of the lungs require careful management, and long-continued rest, as without it injuries which have been repaired may be reproduced. Emphysema is a familiar effect of this class of wounds. When judiciously treated it does not materially increase the danger.

Wounds of the Heart.—Penetrating wounds of the heart are necessarily speedily fatal from hæmorrhage, unless they pass so obliquely through the parietes that the flap acts like a valve, or a foreign body happen to plug the orifice. Death may be delayed, in these cases, for some hours, or even days. The rapidity with which death takes place will depend upon the situation of the wound. Thus wounds of the base will prove more speedily fatal than those of the apex, and superficial wounds dividing the vessels of the heart less promptly than those which penetrate its cavities. John Bell gives the case of a soldier, in whom the apex of the heart was cut with the point of a very long and slender sword, and this soldier lived twelve hours, during which time, as appeared after his death, the heart had, at every stroke,

* See the case more at length in Dr. Taylor's 'Elements of Medical Jurisprudence,' p. 442.

been losing a small quantity of blood, till, in twelve hours, it entirely filled the chest, and the patient was suffocated and died. Another man was wounded with a sword, the point of which cut the coronary artery, which threw out its blood so slowly, that it was two hours before the pericardium filled with blood, and then, after great anxiety, the patient died.* In very rare instances, when the wound does not prove fatal by hæmorrhage, complete recovery has taken place. A case, for instance, is related by Fournier, and authenticated by M. Mansen, chief surgeon to the hospital at Orleans, of a patient, who not only survived a wound of the heart, but may be said to have made a perfect recovery from it, inasmuch as he died at the distance of six years after the receipt of the injury, from disease unconnected with it, and the ball was found embedded in the heart. MM. Ollivier and Sanson have collected a number of cases of penetrating wounds of the heart, with a view of determining the probable period at which these injuries prove fatal. Out of twenty-nine cases of wounds of the cavities of the heart only two proved fatal within forty-eight hours. In the remaining cases, death took place in periods varying from four to twenty-eight days.†

Wounds of the Aorta and Pulmonary Artery are necessarily fatal; but patients have been known to live a few days after small punctured wounds even of the aorta.

Wounds of the Œsophagus and Thoracic Duct.—Such injuries are necessarily rare from the great depth at which these parts lie. They would be dangerous from the extravasation of their contents. Orfila, however, mentions a case of recovery from a bayonet-wound of the œsophagus.

Wounds of the Diaphragm.—Punctured wounds of the diaphragm itself do not appear to be attended with great danger, but they are rarely uncombined with injury to the parts above or below. Hernia of the stomach has sometimes followed these injuries, and proved fatal. Rupture of the diaphragm from severe blows or falls is not an uncommon occurrence. In the majority of cases the rupture is attended by a fatal shock to the nervous system, and death is immediate. In other instances it takes place after a longer interval, from the protrusion of the viscera of the abdomen into the chest, and the consequent disturbance of the functions of the organs contained in one or both of those cavities.

Wounds of the Abdomen.—Wounds of the parietes of the abdomen may be attended with serious consequences. Death may take place in incised wounds from a division of the epigastric artery. As in the scalp, so here, there is additional danger from wounds of the tendons of the muscles, and the consequent accumulation of matter beneath them. Ventral hernia is a remote consequence of wounds of the parietes of the abdomen. Contusions of the abdomen are generally attended with

* 'Principles of Surgery,' vol. i. p. 468.
† 'Dict. des Sciences Médicales,' art. *Cas rares.*

serious consequences. Sudden death from shock, hæmorrhage from rupture of the viscera, and inflammation, are the chief causes of death. The liver and spleen are the organs most liable to suffer injury, and rupture of their substance is not uncommon.

Wounds of the Liver.—Penetrating wounds of this organ, when they extend to any depth, are apt to prove fatal by dividing some of the large vessels. In other cases the danger arises from inflammation of the organ. Wounds of the gall-bladder prove fatal by causing effusion of bile, and consequent peritonæal inflammation.

Wounds of the Spleen.—Deep wounds are fatal by hæmorrhage; but recovery may take place from superficial wounds. Rupture of the spleen from blows on the belly are not uncommon. They prove fatal, according to the amount of injury in from a few hours to several days. In a convalescent patient, a kick over an enlarged and extremely soft spleen caused the effusion of several ounces of blood, and death in a few minutes. (Dr. Robert Williams, 'Elements of Medicine,' vol. ii. p. 470.)

Wounds of the Stomach.—These prove fatal by the shock to the nervous system, by hæmorrhage, if the large vessels are divided, by the extravasation of the contents and consequent peritonæal inflammation, and by inflammation of the viscus itself. Wounds of the stomach, however, are not necessarily fatal, and many cases of recovery are recorded, even when the wound was extensive, and the stomach distended with food at the time of the injury.

Wounds of the Intestines.—These injuries may prove fatal in the same way as those of the stomach, viz., by hæmorrhage, by effusion of their contents, and consequent peritonæal inflammation, or by inflammation of the part itself. The danger is greater in the small than in the large intestines, in consequence of the more fluid state of their contents, and the greater risk of extravasation. For the same reason, wounds of the duodenum are more dangerous than those of the other small intestines. In the absence of extravasation, there is a fair chance of recovery from wounds of the intestines by the effusion and organization of coagulable lymph about the edges of the incision.

Wounds of the Kidneys.—The kidneys are chiefly exposed to injury from blows and stabs in the loins. Penetrating wounds of these organs may prove fatal, in consequence of hæmorrhage, extravasation of urine, or inflammation. If means are taken to prevent the urine from being effused into the peritonæal cavity, recovery may take place.

Wounds of the Bladder are chiefly dangerous from extravasation of urine, which is, of course, most apt to occur when the organ is distended. In the absence of effusion they may prove fatal by the inflammation to which they lead. Rupture of the bladder, though ultimately fatal, does not destroy life rapidly; and the accident does not immediately prevent the patient from walking about.

Wounds of the Genital Organs.—A removal of the penis, if not fatal by hæmorrhage, is not dangerous; but an incised wound of the urethra entails the risk of extravasation of urine into the cellular membrane and fatal sloughing. The removal of the testicles is attended with less danger than a contusion. This latter injury sometimes proves fatal by the shock to the nervous system. Wounds of the spermatic cord occasion dangerous hæmorrhage. The complete removal of all the parts of generation of the male has in many instances led to no bad result. Deep wounds of the labia of the female are dangerous from hæmorrhage. Fatal injuries have been inflicted on the uterus, bladder, or rectum, or on the large vessels of the pelvis, by instruments introduced into the vagina.

Consult Mr. Watson's 'Medico-legal Treatise on Homicide.'

CHAPTER IV.

DEATH BY FIRE—SPONTANEOUS COMBUSTION—DEATH BY LIGHTNING—BY COLD—BY STARVATION.

DEATH BY FIRE.

On the average of the five years 1852-56, no less than 2,623 deaths in England and Wales were attributed to the agency of heat. Of this number 483 were burns, of which 436 by clothes catching fire, 15 by conflagrations, 24 by gunpowder and fireworks, and 7 by explosive gases. 1,548 deaths from the same causes were less accurately defined. 46 deaths were caused by drinking hot water; and 541 death by scalding liquids. In the whole five years 2 suicides, 1 murder, and 4 manslaughters were attributed to burning, and 2 manslaughters to scalds.

The medico-legal questions that arise in reference to death by fire are similar to those relating to other forms of external injury, except that the alternatives of suicide and homicide very rarely present themselves. The great majority of deaths by fire are accidental. In accidental cases, and in the few cases of suicide and murder, the burning would leave marks on the body showing that it was inflicted during life; but as it is known that the burning of the body after death is sometimes resorted to by a murderer to conceal the real cause and mode of death, it may be of the utmost importance to distinguish burns inflicted during life from burns inflicted after death. Another medico-legal question may arise when a body is found with marks of injury by burning too extensive to be readily accounted for by the quantity of fuel consumed. It may become a question whether the body so injured was unusually combustible, or whether it might not even be the subject of "spontaneous combustion." This second question will be separately examined. The first question will be now considered.

Distinction between burns inflicted during life and after death.—We owe the earliest experiments on this subject to Dr. Christison. But the results which he arrived at have been somewhat modified by subsequent experimental inquiries in France and Germany, but especially by those of Champouillon and Chambert. The last-named author seems to have exhausted the subject both by the number and accuracy of his experiments, and we shall therefore adopt the conclusions at

which he has arrived, with some modifications suggested by the more certain of the results of the earlier writers.

Burns inflicted during life by bodies not so highly heated as to char and destroy the tissues, produce two characteristic appearances—redness and vesication. The redness, more or less intense according to the temperature and the length of its application, affects the surface and entire substance of the true skin, which is dotted by the deep red openings of the sudoriferous and sebaceous ducts; and it also extends to the subcutaneous tissues. Blisters, more or less numerous and extensive, also make their appearance under a temperature below that of boiling water, and contain serum, which either coagulates in mass, or yields an enormous precipitate of albumen when heated, or treated with nitric acid. The albumen is more abundant when wholly due to vital action than when the burn, being inflicted at the point of death, the vesicle forms after life is extinct. These appearances belong equally to burns made at the point of death and to those made twenty hours previously, but vesicles, though generally present, are sometimes absent in burns whatever the period at which they were inflicted.

On the other hand, in burns inflicted after death, the surface and substance of the true skin are of a dull white colour, dotted with grey at the openings of the sudoriferous and sebaceous ducts, and the subcutaneous tissues are uninjected. No vesicles are produced by a temperature below the boiling point; and those occasioned by a higher temperature either contain no fluid, or one which, as it contains little albumen, merely becomes opaline or milky when treated by heat or nitric acid. Post-mortem vesicles are most readily produced in anasarcous subjects.

The appearances just described as caused by burns inflicted during life, show themselves in all healthy subjects, and probably in the large majority of sick persons; but the case of a consumptive patient reported by M. Bouchut, shows that the application of heat to the skin of a dying man may produce as little effect upon it as upon a corpse.*

It should be understood that the appearances just described as due to the application of heat to the living body are common to all the more intense inflammations of the skin, however produced; to the application of cantharides and other strong stimulants, to pressure and friction, and even to idiopathic inflammations of the skin. I have seen, on the ankles of a young man who had died of acute phthisis, two patches of inflammation of a deep red colour not removable by pressure, and with well-defined margins, on one of which were large vesicles containing serum. In this case, I ascertained beyond doubt that the spots, which had been observed during life, were not caused by the application of any heated body. In all these cases of acute cutaneous inflammation, a thin vertical section of the inflamed skin and underlying tissues displays, even to the naked eye, distinct red patches, contrasting very

* This case is quoted by Chambert in an elaborate paper in the 'Annales d'Hygiène,' April, 1859, to which the reader is referred.

strikingly with similar sections of skin discoloured by the mere subsidence of the blood.

It is scarcely necessary to add that redness follows instantly on the application of heat, and that vesicles show themselves after the interval of a few seconds.

SPONTANEOUS COMBUSTION.

The following case, which rests on the authority of Le Cat, a firm believer in the doctrine of spontaneous combustion, forms a fitting introduction to this subject. It is said to have taken place in 1725.

A man of the name of Millet, living at Rheims, was charged with the murder of his wife. It appears that the body of the deceased was found lying in the kitchen of the house at a short distance from the hearth, entirely consumed. A part of the head only, with a portion of the lower extremities, and a few of the vertebræ, had escaped combustion. The floor beneath the body was partially burnt. The prisoner, in his defence, stated that he and his wife had retired to rest the previous evening,—that his wife, not being able to sleep, got up and went into the kitchen, as he supposed to warm herself. He was awakened by the smell of fire, and going down into the kitchen, discovered the deceased lying near the hearth, in the manner stated. The prisoner was condemned to death for the murder, but, on appeal to a higher court, the sentence was revoked, and it was pronounced to have been a case of spontaneous human combustion.

In this case the extent to which the body was consumed might lend some support to the opinion, that it was more combustible than human bodies in general, but it gives no countenance to the notion that the fire originated in the body itself. It was certainly in the most favourable circumstances for being *set on fire;* and this is true of most of the reported cases of alleged spontaneous combustion which have occurred both in this country and abroad.

Orfila testifies his belief in spontaneous human combustion by thus describing the phenomena which accompany it:—A light blue flame appears over the part which is about to be attacked: this flame is not readily extinguished by water, and indeed frequently the addition of this liquid only serves to increase its activity. Deep eschars now form in the part affected, accompanied by convulsions, delirium, vomiting, and diarrhœa, followed by a peculiar state of putrefaction, and death. The process is said to advance with extreme rapidity, but the body is never entirely consumed: some parts are only half burnt, while others are completely incinerated, a carbonaceous, fetid, unctuous ash remaining. The hands and feet commonly escape destruction, while the trunk is usually entirely dissipated. The wooden and other combustible articles of furniture situated near the individual are either uninjured, or but imperfectly consumed; the clothes, however, covering the body are commonly destroyed. The walls and furniture of

the apartment are covered with a thick greasy soot, and the air is impregnated with an offensive empyreumatic odour. This phenomenon is stated to have been chiefly observed in corpulent females, advanced in life, and especially in those subjects who had been long addicted to the abuse of spirituous liquors.

It is, perhaps, practically of little consequence whether the doctrine of *spontaneous* combustion be true or false. The cases on record may be fairly allowed to prove an unusual degree of combustibility of the human body, occurring in rare instances and, for the most part, in corpulent spirit-drinking females, merely requiring to be set on fire, and needing no other fuel but their clothes, night-dress, or ordinary bed-furniture. Till we possess cases better authenticated, and more accurately reported, we must content ourselves with this amount of knowledge.

The spontaneous combustion of inorganic substances is a subject of much interest and importance, but it has no medico-legal bearing.

DEATH BY LIGHTNING.

From the Reports of the Registrar-General for the five years 1852–56, it appears that about 21 deaths by lightning occur, one year with another, in England and Wales; 18 in males and 3 in females. This mode of death rarely gives rise to questions of a medico-legal nature; but inasmuch as the effects sometimes produced on the body, both externally and internally, resemble those inflicted by mechanical violence, a question might possibly arise, whether a person found dead, under unknown circumstances, had perished from the effects of lightning, or had been murdered.

In the majority of cases we shall have a clue to the cause of death, by knowing that a thunder-storm has taken place near the spot on which a body is found. This fact being ascertained, we shall next have to inquire what probability there was of the body having been struck by lightning.

As a general rule it may be stated, that the electric fluid prefers and seeks out good conductors; and as the human body is a very good conductor of electricity, it is as likely to be struck as any object similarly situated, unless, perhaps, that object be of metal.

As a general rule, too, lofty objects are more likely to be struck than low ones; but this rule is subject to many exceptions, for persons have been struck in the immediate neighbourhood of lofty trees which have been uninjured.

The electric fluid is often conducted to the human body by lofty objects in its proximity, such as trees, masts and rigging of ships, and the moist strings of kites. The danger of remaining under a tree during a storm is proverbial.

It has been thought that a person is tolerably safe in an open space far from any object which could attract the electric fluid; but this is

an error. The human body may be, in these circumstances, the most prominent object, and, at the same time, the best conductor.

It is now understood that death may be caused by an electric shock, other than the lightning stroke. This takes place when a cloud, in near proximity to the earth, is negatively electrified, whilst the earth is positive. The human body is here made the conductor, by means of which the equilibrium is restored. This is called the *ascending* or *returning stroke*.

The violent effects produced by the electric discharge—the disruption of the several parts of a building, and their forcible removal to a distance; the separation of the good conductors from the bad ones; the fusion of metallic substances; the ignition of inflammable ones; the magnetic properties communicated to articles of iron and steel—are familiarly known.

The *Post-mortem appearances* in the bodies of those who have been struck by lightning are very various. Sometimes no marks of violence are found on the body, and this is said to occur most commonly in cases of death produced by the *returning* stroke. At other times the body presents marks of violence, such as contusion and laceration about the spot where the electric fluid has entered; occasionally there is merely a small round hole at the point of exit; at other times there is an extensive ecchymosis, and this is most commonly found on the back, the electric fluid appearing to prefer the track of the spinal marrow. Fracture of the bones is a rare occurrence. They may occur, as Ambrose Paré states, without external wound. One case of extensive fracture of the bones of the skull is related by Pouillet. Marks of burns are not frequently met with, and probably never, except in cases where the clothes have been set on fire.

The state of the blood, alleged by some authorities to be fluid, by others to be coagulated; the state of the limbs, asserted by some authors not to grow rigid, but by other authors, with better reason, to be subject to rigidity, and sometimes even to become quickly and excessively rigid; and the putrefactive process, stated by Paré and others to be retarded, but by other authorities to be hastened,—are trivial signs, of little medico-legal importance. The state of the body in these respects is worthy of note; but even should it be clearly made out that the blood is fluid, rigidity absent, and putrefaction hastened, these circumstances could not be considered peculiar to death by lightning, for there is reason to believe that all of them may coincide in other modes of sudden death.

In some cases the state of the objects found upon the person furnish very complete evidence of the cause of death. The clothes may be torn and burnt; metallic bodies fused and forcibly carried to a distance from the body; and articles of iron or steel, such as the steel of the stays, or the main-spring of a watch, rendered strongly magnetic.

Cause of Death.—The power of the electric fluid shows itself chiefly through the nervous system. If death takes place, it is through the

shock sustained by it; or if a less degree of injury is inflicted, it is manifested on the brain, spinal marrow, or nerves, in loss of sight, sensation, or voluntary motion, temporary or permanent.

DEATH FROM COLD.

Death from cold is an uncommon event in this country, though death by cold and inanition combined is not of very rare occurrence in severe winters.

The first effect of intense cold is a sensation of numbness and stiffness in the muscles of the limbs and face. This is soon followed by torpor and profound sleep, passing into coma and death.

The effects of cold are manifested partly on the general circulating system, and partly on the circulation through the brain.

The effect on the circulating system generally is to drive the blood from the surface to the interior of the body, so as to gorge the spleen, liver, lungs, and brain with blood. The genital organs are similarly affected, priapism sometimes resulting from congestion of the vessels of the penis. The temperature of the blood itself is lowered; the heart contracts slowly and feebly, and the pulse becomes small and thready.

The congestion of the nervous centres occasions numbness, torpor, somnolency, giddiness, dimness of sight, tetanus, and paralysis; and the congestion of the brain sometimes occasions a species of delirium as happened to Edward Jenner, or the appearance of intoxication, as witnessed by Captain Parry and others in the expeditions to the North Pole.

The effect of cold varies in intensity in different persons according to their sex, age, and strength: the young, the aged, the infirm, persons worn out by disease or fatigue, and those addicted to the use of intoxicating liquors perish most promptly. It would appear, too, that, independent of these circumstances, some persons have a great advantage over others in their power of resisting cold—a fact frequently observed by voyagers and travellers in the Arctic regions.

The circumstances which cause the impression of cold on the body to be severely felt, and which give rise to effects not indicated by the height at which the thermometer stands will be understood from the following considerations:—

The body is cooled in three ways—by cutaneous exhalation; by conduction from the direct contact of air; and by radiation.

The *cutaneous exhalation* is increased by dry and diminished by moist air. The body, therefore, parts with its heat more rapidly in a dry atmosphere.

On the other hand the body is cooled by *conduction*, when the air is moist; so that the body is cooled alike by dry cold air and by cold moist air.

Cold humid winds lower the temperature of the body in a very striking degree.

A rapid renewal of the air, as in a brisk cold wind, lowers the temperature of the body by evaporation and by conduction at the same time. The effect of a slight breeze in increasing the feeling of cold was remarkably exhibited in the expeditions to the polar seas.

Post-mortem Appearances.—The surface of the body is pallid, and the viscera of the head, chest, and abdomen are congested. There is congestion of the vessels of the brain, but extravasation does not appear to have been noticed, though the old opinion of the cause of death was in favour of apoplexy. In two cases reported by Dr. Kellie, of Leith, there was a large effusion of serum in the ventricles of the brain. The blood in the aorta and left cavities of the heart is stated by Dr. Paris, on the authority of Sir B. Brodie, to be florid. It will be seen that none of these appearances are so characteristic as to be in themselves conclusive as to the cause of death.

DEATH FROM STARVATION.

This is an extremely rare event; but death from cold in persons insufficiently nourished is not infrequent. Cases of homicide by the deprivation of food, are of occasional occurrence, and insane persons, and those who seek to avoid some greater calamity, such as capital punishment, sometimes commit suicide by obstinately refusing to take sustenance.

The Symptoms produced by protracted Abstinence are pain in the epigastrium, relieved by pressure; emaciation, the eyes and cheeks sunken, the bones projecting, the face pale and ghastly, the eyes wild and glistening, the breath hot, the mouth dry and parched, intolerable thirst, delirium, extreme prostration of strength.

After a longer interval the body exhales a fetid odour, the mucous membranes of the outlets become red and inflamed, and death takes place in a fit of maniacal delirium, or in horrible convulsions.

The period required to produce fatal effects varies with the age, sex, and strength, and with the amount of exertion; and it also depends in a great degree on the command of liquids, for the experiments of Redi have shown, that animals live more than twice as long when they have access to water as when they are kept without it.

Cases are on record in which life has been prolonged under voluntary starvation for a considerable period; in one case (that of Viterbi), twenty-one days, and in a still more remarkable one, fifty-eight days. This, which occurred in the south of France, and was reported to the Academy of Medicine, is as follows:—

Guillaume Granet was a prisoner at Toulouse, and he resorted to starvation to avoid punishment. For the first seven days the symptoms were not very remarkable; his face was flushed, his breath foul, and his pulse small and feeble. After this period he was compelled to drink water occasionally, to relieve the excessive thirst which he suffered, but in spite of the close watch which was kept over him, he

frequently drank his urine, or the water of the prison-kennel. His strength did not appear to fail him during the greater part of the time, and, with varying symptoms of constitutional disturbance and acute sufferings, he lingered till the fifty-eighth day, when he expired, after struggling for four hours in convulsions.*

Post-mortem Appearances.—The body is much emaciated, and exhales a fetid odour; the eyes are red and open, the skin, mouth, and fauces dry, the stomach and intestines empty and contracted; the gall-bladder is distended with bile; the heart, lungs, and large vessels collapsed, and destitute of blood; and putrefaction runs a rapid course. These appearances are not so characteristic as to be decisive of the mode of death; but in the absence of any disease productive of extreme emaciation, such a state of body will furnish a strong presumption of death by starvation. It must be recollected, that there are maladies such as stricture of the œsophagus, and organic disease of the stomach, which prove fatal by starvation. Search should, therefore, be made for such causes of death.

The time that a person may remain without food, or may support life on a very scanty supply of it, may become a question of some importance, as will appear from the case of Elizabeth Canning, quoted by Dr. Cummin in his Lectures in the 'Medical Gazette,' vol. xix. The question raised in this case was, whether a girl of eighteen could be confined, in the depth of winter, twenty-eight days, without fire, with about a gallon of water in a pitcher, and with no food but some pieces of bread, amounting altogether to about a quartern loaf, and a small minced pie which she happened to have in her pocket, and at the expiration of the period retain sufficient strength to break down a window-shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground, nine or ten feet below; and finish by walking from Enfield Wash to Aldermanbury.

To this question we should be strongly inclined to return an answer in the negative. The cases which have been alluded to, and especially that of Guillaume Granet, give us good ground for believing, that life might have been prolonged for twenty-eight days, or even more, on this scanty supply of nourishment; but it is extremely improbable that, at the end of this time, she would have had strength enough left to effect her escape. This case is also curious in its bearing on the question of identity.

The longest abstinence from food, with free access to water, of which I have experience among prisoners is ten days. In two men and one woman complete abstinence from food during this period was followed by no bad symptom, and the ordinary prison diet was resumed without injury to health. The prisoners were weakened, but by no means exhausted.

* Foderé, vol. ii. p. 276.

PART III.

TOXICOLOGY.

The frequent occurrence of cases of real or supposed poisoning, and the complicated nature of the questions to which they give rise, render this the most important division of Forensic Medicine; while the great number of recognized poisonous agents causes it to occupy no inconsiderable part of every medico-legal treatise.

The first suspicion of poisoning usually assumes a somewhat indefinite shape, and the question raised is not so much what poison has been taken as whether any poison has been taken. In seeking a solution of this question it is natural first to consider, to the operation of what class of poisons the symptoms which have suggested the suspicion bear the nearest resemblance; and then to select from the members of that class the individual poison of which the effects correspond most closely with the symptoms in question. This, which is the natural order of inquiry, is also the most convenient one. Accordingly a distinct chapter will be devoted to the subject of Poisons in General; including the definition of the term poison, the mode of action of poisons, the causes which modify their action, the evidence of poisoning, and the classification of poisons.

This chapter will be followed by a series of chapters in which the individual poisons will be grouped according to their analogies, and separately examined.

CHAPTER I.

ON POISONS IN GENERAL.

DEFINITION OF A POISON.

The first question of a general nature which offers itself for solution relates to the meaning of the word *Poison*.

The term poison does not admit of strict definition; but the meaning which ought to attach to it may be ascertained by a simple process of exclusion. A substance which affects one person in consequence of

some peculiarity of constitution, but has no effect upon other persons, is not a poison: a substance which proves fatal in consequence of some temporary condition of system, as cold water swallowed by a person heated by exercise, is not a poison: substances which prove fatal through the mechanical irritation they set up in the internal parts, such as pins and needles, and particles of steel or glass, are not poisons: again, hot water may prove fatal when swallowed, but water being harmless in itself, and injurious only as a vehicle for conveying heat, is not a poison. Substances, therefore, which owe their fatal effects to some peculiarity of constitution, or to some unusual condition of the body; as well as mechanical irritants, and substances naturally harmless, but rendered injurious by extraneous causes, are not to be considered as poisons. The mode in which a substance is applied to the body forms also no part of the definition of the term poison. It may be applied to the skin, or inhaled, or swallowed, or introduced into the anus or vagina, or into the ear, but it is still a poison. Again, the quantity of a given substance which may prove fatal, or the time during which it may continue to act before death takes place, cannot be allowed to enter into the definition; for in both these respects undoubted poisons differ widely from each other. These exclusions have narrowed the possible definition of a poison; and although from the nature of things precision is impossible, the following may be adopted as the nearest approach to a definition:—A poison is any substance which, when applied to the body externally, or in any way introduced into the system, without acting mechanically, but by its own inherent qualities, is capable of destroying life.

In by far the greater number of medico-legal cases poisons are swallowed. Hence the definition of a poison has been sometimes so framed as to exclude all other modes of application; and the words "administer," or "cause to be taken by," which are used in the statute 1 Vict., cap. 85, would seem to imply this mode of introducing a poison into the system.

The word poison is frequently qualified, in common conversation, by such terms as "active" "virulent," "deadly," and the last of these terms is very generally used in indictments.

A "deadly poison" may mean a substance which proves fatal in a small dose, or one which in a larger dose destroys life very rapidly, or one which, irrespective of the dose, is more likely to prove fatal, or more difficult to counteract, than others. Strychnia and oxalic acid, for instance, are both "deadly poisons;" but while less than a grain of the one may destroy life, about half an ounce of the other is required for the same purpose; yet a full dose of oxalic acid may prove much more rapidly fatal than even a large dose of strychnia. On the other hand, Epsom salts or sulphate of potash, in order that they may destroy life, must be given in considerable quantity, and, even when so given, do not prove certainly or rapidly fatal: so that it would obviously be incorrect to designate these substances as "deadly

poisons." Nor would the term be correctly applied to such a substance as sulphate of zinc, which is often prescribed as an emetic in doses of a scruple or half a drachm, or to the non-corrosive preparations of mercury, iron, or copper. In any case the term "deadly poison" is open to the objection of raising an unnecessary verbal question, and unless it is to be looked upon, when used in indictments, as mere "legal surplusage," in accordance with the opinion lately expressed by Mr. Justice Earle, it ought to be allowed to fall into disuse.

"A destructive thing," is another phrase used in the statute just referred to, and open to question. A destructive thing, if not a poison, in the sense ordinarily attached to that term, must be some substance which destroys life by a mechanical action on the internal parts, or by some property not inherent in it, such as heat. Some substances, as sponge, or plaster of Paris, may destroy life by presenting an obstacle to the passage of the contents of the intestines; others, as large particles of glass or steel, by irritating the lining membrane of the alimentary canal; and pins or needles, by wounding vital organs, or by setting up inflammation in the less important parts which they traverse. Such substances may be fairly regarded as "destructive things;" but whether they have caused death in any particular instance can be determined only by a post-mortem examination.

Having defined the term poison with sufficient precision to indicate the class of substances which will have to be examined in the following pages, certain general questions relating to poisons must next be considered. These are,—*Their mode of action*, and *The causes which modify their action.*

MODE OF ACTION OF POISONS.

The action of poisons is twofold, *local* and *remote*.

The *local* action of poisons may consist in *corrosion*, or chemical decomposition, as when a concentrated mineral or vegetable acid, a pure alkali, or a corrosive salt, is applied externally or taken internally: in *irritation* or *inflammation*, in various degrees, and followed by the several terminations of adhesion, suppuration, ulceration, or gangrene, as from the application of arsenic, tartar-emetic, or cantharides: and, lastly, in an effect on the nerves of sensation or motion; as the numbness and tingling of the lips and tongue, occasioned by chewing the leaves, seeds, or root of monkshood, and the sharp pricking sensation in the same parts, caused by the arum maculatum; the loss of sensation in the skin by the application of the vapour of prussic acid; and the dilatation of the pupil from the application of belladonna, to the eye.

The *remote* action of poisons is of two kinds, *common* and *specific*: the first resembling the effect of other forms of severe injury inflicted on the same part, and varying in intensity with the amount of that injury; the last being peculiar to the poison itself. Thus, arsenic

when swallowed, and applied to the mucous membrane of the alimentary canal, gives rise to those severe cramps in the extremities which are present in all acute inflammations of the lining membrane of the stomach and bowels, however produced; but the same poison, inserted into a wound, applied to the skin, or inhaled by the lungs, excites inflammation of the mucous surfaces with which it does not come into immediate contact. This is its specific action. Again, oxalic acid acts on the mucous membrane of the stomach and bowels as a corrosive, and excites inflammation around the parts of the membrane which it has destroyed; and this destruction and consequent inflammation are attended with the same constitutional shock that accompanies all severe local injuries; but it has also a remote *specific* effect on the brain and spinal cord, and on the heart. The purest example of a remote constitutional effect of a common kind is afforded by the mineral acids, and by the pure alkalis and their carbonates, which, by the local destruction they occasion, give rise to the common symptoms of collapse—extreme debility, faintings, imperceptible pulse, cold extremities, and death. The absence of remote specific effects in the case of these chemicals has led some authors to doubt the propriety of classing them among the poisons.

The remote specific effects of poisons may also be distinguished as constitutional or local; that is to say, as producing a general effect on the whole frame, or a partial effect on a particular organ. Tartar-emetic, for instance, has a peculiar depressing effect upon the system, and a peculiar local action on the lungs; while arsenic acts as a stimulant to the system, and exerts a local action on the mucous surfaces.

A knowledge of the *specific* remote action of poisons is of the first importance, as it often enables us to judge of the particular poison which has been taken, or of the class of poisons to which it belongs. Thus the narcotic poisons, as a class, occasion stupor, the narcotico-acrids, delirium. Nux vomica, and the several plants of which strychnia is the active principle, affect the spinal cord, producing violent attacks of tetanus; conia, the active principle of hemlock, paralyses the whole muscular system; arsenic, even when applied externally, causes inflammation of the mucous membrane of the alimentary canal; mercury attacks the salivary glands and mouth; cantharides the urinary system; antimony the lungs; manganese the liver (and this is an effect of copper); chromate of potash the conjunctiva of the eyes; iodine the lymphatic glands; lead the muscular system generally (and this, too, is an occasional effect of arsenic); and spurred rye produces gangrene of the limbs. Poisonous substances used in the arts also reveal their effects upon the system through their specific actions. Thus the dropped hand betrays the use of lead, paralysis agitans that of mercury, gangrene of the jaws that of phosphorus, and a peculiar rash, with the formation of small ulcers about the nostrils, ears, bends of the arms, and scrotum, the employment of the arsenite of copper.

In the case of some of these poisons, one part or set of organs only is

affected, but others attack almost every important organ of the economy. The most striking example of this kind is arsenic, which, besides producing inflammation in the parts with which it comes in contact, affects all the mucous surfaces, as well as the organs of circulation, respiration, and innervation; and all these effects may be exhibited in the same case. Oxalic acid and the salts of mercury produce similar complications.

In producing these remote specific effects, poisons must either be carried by the circulation to the parts affected, or their action on the nerves of the part to which they are applied, must be propagated to the nervous centres, and thence reflected to the organs remotely affected. Now there is abundant proof of the absorption of poisons, and their consequent circulation through the system. Experiments on animals have shown that this takes place in whatever manner the poison is applied to the body; and the results of such experiments have been confirmed by the analysis of the blood and secretions, and even of the solid textures; the list of the poisons thus detected including almost every substance which can be recognized by its odour or colour, or which, not being decomposed by the animal fluids or textures, can be submitted to chemical reagents. Hence the bare fact of the absorption of poisons is too generally known and admitted to require additional proof or illustration; but the questions arise—Is it in consequence of absorption that poisons prove fatal? Is their action arrested or postponed by the arrest of the circulation?

As the greater number of experiments which have been made in illustration of these questions have consisted in the introduction of poisons into wounds, it may be well to consider by themselves the arguments derived from this mode of introduction. In the first place, it has been satisfactorily shown, that poisons so introduced do not act directly on the nerves of sensation or volition, for their action is not impaired by the previous division of the nerves supplying the part into which the poison is introduced, and they continue to take effect even when, as in Majendie's well-known experiment, the poisoned limb is connected with the body only by quills introduced into its large vessels. It is also clear that the great nervous trunks are not able to transmit the poisonous influence, for poisons inserted into a limb do not produce their effect when the limb is connected with the body by nerves only. Again, a division of the spinal marrow does not prevent the action of those poisons which prove fatal by attacking that part, and the direct contact of poisons with the substance of the brain itself has been found to be unattended with their usual effect. This class of experiments, therefore, affords a very strong presumption in favour of the necessity of absorption to the action of poisons.

But the introduction of poisons into wounds is only one way in which they may gain admission into the body. It is necessary to inquire how poisons which have been swallowed produce their effects. Is absorption necessary to their fatal action? An experiment performed by Mr. Blake proves this necessity as strongly as in the case

of poison inserted into wounds. Prussic acid was introduced into the stomach through an opening in its parietes; it produced no effect, so long as the vessels entering the liver were secured by a ligature, but began to act within one minute after its removal.*

It appears, then, that poisons, whether inserted into wounds or introduced into the stomach, produce their fatal effects in consequence of absorption, and that, where absorption is altogether prevented, these effects do not occur. The question now arises—In what manner do poisons, introduced into the blood and circulated through the system, produce their fatal effects? On what part and on what tissue do they act?

It is plain that all poisons do not destroy life in the same way. Some paralyse the heart, others act directly upon the lungs, and give rise to asphyxia; a third class attack the brain; a fourth the spinal marrow; and a fifth class appear to affect the entire capillary circulation. This difference of action is displayed in a marked manner when poisons are introduced, as in the experiments of Mr. Blake, directly into the current of the circulation. So introduced, the salts of magnesia, lime, strontia, and baryta; of zinc, copper, lead, and silver; as well as oxalic acid and digitalis, affect the heart; the salts of soda, hydrocyanic acid, tobacco, and euphorbium attack the capillaries of the lungs; opium and its alkaloid, morphia, affect the brain; while the action of the salts of potash and ammonia seems to be limited to the general capillary circulation.† These different modes of death can only be accounted for in one of two ways,—the poison must be conveyed with the blood to the organ affected, or some powerful influence must be transferred to that organ from the nerves distributed to the coats of the blood-vessels themselves. The latter supposition seems, in the highest degree, improbable; for in a second experiment performed by Mr. Blake, blood poisoned with woorara continued to traverse both the arteries and veins of the abdominal viscera for several minutes before any effect manifested itself. This experiment, taken by itself, affords a sufficient refutation of the theory which the ingenious experiments of Morgan and Addison were intended to establish. Considerable and very important additions have been lately made to our knowledge of the action of poisons, and of the proximate cause of death in poisoning, by M. Claude Bernard. He has shown by well-devised experiments on animals that the more active poisons attack particular tissues or organs essential to life—that woorara paralyses the motor nerves; that strychnia attacks the sensitive portion of the nervous system, and excites fatal reflex actions; that digitalis, upas antiar, corrowal, and wao, veratrine, and several other poisons, act on the muscular tissue throughout the body, and on the heart as a muscle.‡

* For minute particulars of this and of similar experiments see Mr. Blake's Essay in the 'Edin. Med. and Surg. Journal,' vol liii. p. 45.

† 'Ed. Med. and Surg Journal,' vols. li., liv., and lvi.

‡ See his lectures in the 'Medical Times and Gazette,' vol. ii. 1860, Nos. 532, 533, 535.

There remains, then, but one explanation of the action of poisons when once introduced into the blood-vessels, namely, that they are carried with the blood to the organs or tissues on which they act: some by the coronary arteries to the heart, which they paralyse; others to the spinal marrow, exciting fatal tetanic spasms; others to the brain, proving fatal by an indirect action on the respiration; and others, again, to the lungs, causing an arrest of the capillary circulation, and consequent asphyxia.

One difficulty which stood in the way of the reception of the theory of the necessity of absorption to the action of poisons, namely, the rapidity with which certain poisons, such as prussic acid, prove fatal, has been removed by the ingeniously-contrived and carefully-performed experiments of Mr. Blake. Having provided a delicate measure of the condition of the circulating system, by inserting into the femoral artery of the animal to be experimented on, the hæmadynamometer of Poiseuille, he proceeded to ascertain the time required for the circulation of poisons from one part of the system to the other. This he effected chiefly by introducing various substances, previously known to paralyse the heart, directly into the vessels, and, by means of the instrument, noting the instant of time at which the first effects of the poison manifested themselves, and at which the heart ceased to beat. Without entering into a minute account of the experiments themselves, it may suffice to state, that, in the dog, the time required for a poison to pass from the jugular vein to the lungs was four seconds, or from four to six seconds; from the jugular vein to the coronary arteries of the heart seven seconds; from the jugular vein to the carotid artery five to seven seconds, and from the aorta to the capillaries, four seconds. A poison introduced into the jugular vein was distributed through the whole body in nine seconds. In the horse, the time required for the completion of the circulation was from twelve to twenty seconds, or somewhat less than the time (twenty-five seconds) deduced by Hering of Stuttgardt, from his experiment.

These experiments are in harmony with the more recent ones of M. Claude Bernard. A saturated solution of sulphuretted hydrogen, introduced into the jugular vein of a dog, began to be eliminated from the lungs in three seconds; and when injected into the femoral vein of the same dog, in six seconds.

Assuming that the time required for the complete circulation of a poison through the body of a dog is nine seconds, it follows that if it can be shown, that poisons applied to the dog's tongue do not act in so short a space of time, absorption may take place, and the blood may be distributed to the organ on which it produces its fatal effects. Now, in Mr. Blake's experiments, strong hydrocyanic acid applied to the tongue of a dog did not begin to act till eleven seconds, and did not prove fatal till thirty-three seconds; and when a tube was previously introduced into the larynx, so as to prevent the vapour of the acid from entering the lungs, the first appearance of the symptoms was after

sixteen seconds, and death took place in forty-five seconds. In like manner, nicotina, the essential principle of tobacco, applied to the tongue of the same animal, did not prove fatal till twenty seconds. These experiments afford very strong confirmation to the theory of the necessity of absorption to the fatal action of poisons, and must be admitted to prove that necessity, at least in the great majority of cases. If the theory of the fatal action of poisons by an effect produced on the nerves of the part to which they are applied be tenable, it must be in those rare instances in which the fatal action of the poison is reported to have been literally instantaneous, or much more prompt than in any of Mr. Blake's experiments. Such an experiment is reported by Dr. Christison, who states, that in one instance an animal was killed outright by prussic acid in four seconds;* and cases are cited by the same author, and by Dr. Taylor,† in which the same poison destroyed life in three, and even in two, seconds; and in the experiments of Sir Benjamin Brodie, alcohol and the essential oil of bitter almonds seem to have produced the same instantaneous effect.‡

In the presence of these facts, and with the knowledge we possess of the instantaneous impression produced upon the system by sudden and extensive mechanical and chemical injuries, it would scarcely be safe to deny the possibility of the more active poisons when taken in large doses proving fatal by a sudden shock to the system.

A fact reported by Sir B. Brodie renders it probable that poisons may act through continuity of tissue. A man was bitten in the hand by a rattlesnake. There was inflammation, sloughing, and suppuration of the cellular tissue of the arm, and copious and extensive extravasation of blood beneath the integuments of the chest and back, limited to the injured side of the body.

The theory of absorption finds a practical application in the use of ligatures and cupping-glasses for preventing the effects of poisons inserted into wounds.

CAUSES WHICH MODIFY THE ACTION OF POISONS.

There are three ways in which the action of poisons may be modified. 1. By the quantity and form in which they are administered. 2. By the part of the body to which they are applied; and 3. By the condition of the body itself.

1. *Quantity and Form of the Poison.—Quantity.* As a general rule, the larger the quantity of a poison introduced into the system the more prompt and the more severe its effects; but in the case of poisons which are swallowed, a large dose will sometimes be immediately and completely discharged by vomiting, while a smaller dose will remain

* 'Treatise on Poisons,' p. 7.
† 'Medical Jurisprudence,' 5th Edition, p. 160.
‡ Sir Benjamin Brodie's 'Physiological Researches,' p. 139.

on the stomach, and prove fatal. Again, small doses of a poison often repeated, will develop different symptoms from those caused by a single large dose. The operation of some poisons also varies remarkably in kind as well as in degree with the quantity taken. Thus oxalic acid in a large dose may destroy life almost instantly by shock; in a smaller dose it may affect the heart in a less degree, but still prove fatal by its action on that organ; in a yet smaller dose it affects chiefly the spinal cord; and in a more minute dose still, the brain. Of the whole class of narcotico-acrid poisons, it may be affirmed, that when given in large doses they act chiefly as narcotics, and in smaller doses chiefly as irritants. *Form.*—Under this head will have to be considered,—*a. The State of Aggregation. b. The Chemical Combination*, and *c. The Effect of Mixture.*

a. The State of Aggregation.—Poisons in solution act more energetically than when in a solid form, partly because they are more readily absorbed, and partly because they are brought into contact with a larger surface. For the same reason soluble poisons are much more active than those which are sparingly soluble, and the soluble salts of a poison more active than the less soluble base. Poisons also act when in a state of vapour, with great energy on the lungs and skin. But poisons are not merely rendered more active by solution: their effects are also modified by it. Of this oxalic acid is a remarkable example.

b. Chemical Combination.—As a general rule, substances which have a purely chemical action, as the mineral acids and the alkalis, lose their active properties when in combination. The resulting substance obtains new properties, and is more or less active as it is more or less soluble. Acid poisons, in combining with bases, or basic poisons combining with acids, become more or less active as the resulting compounds are more or less soluble; and, as a general rule, those compounds retain in their soluble combinations the specific characters of their active ingredient. Thus all the soluble salts of morphia have the same action, and all the soluble compounds of oxalic acid affect the system in the same way. When two poisonous substances combine to form one chemical compound (as arsenious acid with copper, or hydrocyanic acid with mercury or silver), the resulting compound may give rise either to the symptoms of the more active element, or to the mixed effects of the two poisons; or it may produce symptoms peculiar to itself. Lastly, some poisons insoluble in water, as arsenite of copper, and carbonate of lead or baryta, may be rendered soluble and active by the juices of the stomach, or by the acid of the perspiration.

c. Mixture.—All admixtures which render a poison more soluble render it more active. All other admixtures have a contrary effect. Thus acids increase the activity of opium, and of the salts of copper, and water of arsenic. Mucilaginous substances, on the other hand, partly by protecting the coats of the stomach, and partly by involving the poison, if in substance or in powder, retard or prevent its action. Food taken before or with poison has the same effect. Hence the

frequent escape of those who have taken very large doses of arsenic or corrosive sublimate. Poison mixed with food is similarly affected by the character of the food. Thus arsenic given in a solid dumpling would manifest its effects much more slowly than if taken in porridge, and in this latter case than if mixed with tea, beer, or water. So also with the more deadly poisons when given in the form of medicine. Thus strychnia given in a pill acts more slowly than the same poison administered in a draught or mixture. We avail ourselves of the protecting effect of admixture with mucilaginous substances in the treatment of cases of poisoning, and we use substances possessed of little or no power as antidotes, because they possess the property of withdrawing and holding in suspension certain poisons. Powdered charcoal is the best example of this class; but magnesia and the sesquioxide of iron given in poisoning by arsenic owe their repute chiefly to this power.

2. *The Part to which the Poison is applied.*—The effect which the same poison has on different parts of the body is directly as the absorbing power of those parts. Thus poisons act most promptly when injected into a vein; next in degree when introduced into a wound; the serous surfaces hold the next place; then the stomach; and, last of all, the unbroken skin. Poisons introduced into the lungs, whether in a fluid or a gaseous form, act with nearly as great rapidity as when introduced directly into the circulation. The corrosive poisons and stronger irritants produce an effect proportioned to the importance of the part to which they are applied. Thus, the mineral acids prove speedily fatal if they come into contact with the windpipe; less speedily by acting on the gullet and stomach, and they are still less active when applied to the skin. It is a remarkable fact, that even those poisons which most strikingly affect the nervous system do not act when applied directly to the brain, spinal marrow, or trunks of the nerves. Many animal poisons, which, as a class, are readily decomposed, have, as might be anticipated, no effect on the stomach, though the smallest quantity introduced into the skin proves certainly fatal. Thus the poison of the viper or mad dog may be swallowed with impunity.

3. *The Condition of the Body itself.*—Under this head will have to be considered,—*a. Habit. b. Idiosyncrasy. c. Disease.*

a. Habit.—It is not possible to lay down any broad general rule in reference to the influence of habit on the effect of poisons. For while some poisons derived from the vegetable kingdom, and belonging to the class of narcotic or of narcotico-acrid poisons, as opium, alcohol, and tobacco, lose their effect by repetition, and may be taken at length in doses which would poison a man not accustomed to their use, other poisons belonging to the same classes, as digitalis and strychnia, have a cumulative effect. Again, though the less deadly mineral poisons, such as the common salts of zinc and iron, may be taken by healthy persons in continually increasing doses, the more active poisons, such as arsenic and mercury, seem to share with strychnia and digitalis a cumulative property; and when gradually introduced into the system

in their use in the arts, they certainly appear, like the carbonate of lead, to be the more dangerous the longer they are used. Nor does habit seem to render men who work with arsenite of copper more tolerant of the poison. The same effects appear to be reproduced at each resumption of their employment. The stomach may, however, become accustomed to the local action of poisons, and grow nearly insensible to them, as happens with the spirit-drinker; and it is perhaps possible that the stomach may become tolerant of increasing doses of arsenic or corrosive sublimate. It must be borne in mind, however, that even those substances to the action of which the system most readily adapts itself, produce permanently injurious effects on the system. Thus, alcohol causes disease of the lungs, liver, kidneys, and brain; tobacco, however frequently repeated, still excites the circulation; and opium injures the digestion, emaciates the body, and enfeebles the mind.

b. Idiosyncrasy.—There are three ways in which individuals differ from each other, or from the majority of their fellows. 1. They are affected in a greater or less degree than is usual by a substance which produces the same effect in them as in other men. Thus, a few grains of mercury shall salivate one man, but as many drachms or ounces shall not affect another. The same remark applies to arsenic. A child, too, shall bear a larger quantity of mercury than an adult; probably because his functions being more active, the substance is sooner removed from the system by the secretions. 2. A substance which, in the majority of persons, produces one given effect, shall in an individual act in a very different manner. Thus, common Epsom salts have been known to act like opium, and opium to have a purgative effect. Lastly, a simple article of diet, which has no more effect on most men than any other food that they take, shall act like a poison on the stomach of a few individuals. Thus, certain kinds of fish and vegetables, and even common butcher's meat, act like irritant poisons on some persons. Even mutton has been known to act invariably in this way.

c. Disease.—The general effect of a state of disease is to render the body less susceptible of the action of poisons. Thus, persons in an advanced stage of typhus fever, or otherwise reduced to extreme weakness, are scarcely affected by stimulants which would overpower the strong; and this is seen even in healthy persons in the increased tolerance of spirits towards the after-part of the day, when the body is comparatively weak. In continued fever and in yellow fever there is increased tolerance of mercury, but in paralytic affections, and in anæmic states of system, an opposite condition prevails: in anæmia, large doses of preparations of steel are readily borne; in severe dysentery, cholera, and hæmorrhage, of opium; in all the more severe affections of the nervous system, as tetanus, hydrophobia, delirium tremens, and mania, every remedy, but especially the narcotic poisons, may be given in greatly increased doses. Delirium tremens may be safely and suc-

cessfully treated by half-ounce doses of tincture of digitalis, and opium may be given in one form of mania in repeated doses of two scruples. The only exception to the general rule here laid down is in the case of poisons which tend to produce conditions of system similar to those actually existing. Thus, the irritants would increase gastritis, diarrhœa, or dysentery; and the narcotics exasperate a determination of blood to the brain.

Besides these three principal modifying causes, there is one condition of system which deserves mention as tending to diminish the operation of poisons, viz. sleep. This is too obvious to require any comment, as in this state all the functions are carried on more slowly, and all effects on the system must of necessity be less severe. On the same principle, substances which produce sleep being administered with or before other poisons, must weaken or counteract their effects; opium, for example, when given with arsenic not only masks the symptoms proper to that poison, but appears to retard its operation.

EVIDENCE OF POISONING.

Under this head it is proposed to examine very briefly the chief circumstances which would lead us to believe that an illness or death, accompanied or preceded by suspicious symptoms, was due to poison, using the term poison in a general sense. There are five such circumstances. 1. The symptoms. 2. The post-mortem appearances. 3. The results of experiments on animals. 4. Chemical analysis. 5. The conduct of suspected persons.

1. *The Symptoms.*—In most cases of poisoning the symptoms appear suddenly, in a person in good health, soon after the taking of food, drink, or medicine, and they run a rapid course towards a fatal termination.

The *sudden appearance of the symptoms* affords a slight presumption in favour of poisoning, for, when administered, as poisons commonly are in criminal cases, in large doses, the symptoms soon show themselves. But, on the other hand, when given in small and repeated doses, the invasion of the symptoms is often gradual. It must also be recollected that many diseases set in suddenly. This is true of many cases in almost all severe epidemics, as in plague, cholera, and yellow fever; typhus fever also. and the febrile exanthemata—small-pox, scarlatina, and measles—show themselves suddenly with severe symptoms of indisposition. Many diseases of the more important organs also set in suddenly; such as perforation of the stomach or intestines, and rupture of other important viscera, organic diseases of the heart, and apoplexy.

The occurrence of the symptoms in a person in good health, also affords only a slight presumption in favour of poisoning; for, on the one hand, many acute diseases make their attack without any previous impairment of health; and, on the other, it is not unusual to administer poison to a person already suffering from illness, or to give a deadly

poison to a person whose health has been previously undermined by the administration of a less-active substance (*e g.* acetate of morphia or strychnia after tartar-emetic, as in Cook, the victim of Palmer).

The appearance of the symptoms soon after the taking of food, drink, or medicine, affords a somewhat stronger presumption; for all the more active poisons when given in large doses, especially if the poison be very soluble, act with great promptitude. On the other hand, it must be borne in mind, that vomiting and other symptoms of indisposition often manifest themselves after a meal containing no unwholesome substance; that apoplexy may follow a full meal; that rupture of the stomach, when its coats are softened by previous disease, would naturally take place while the organ was distended with food; that English cholera is often caused by unripe fruits, putrid meat, or other unwholesome ingesta; and that a large draught of cold water, swallowed while the body is heated, may produce instant death.

The probability derived from the symptoms occurring soon after a meal would be greatly strengthened if other persons partaking of the same meal were similarly affected; but, at the same time, too much importance should not be attached to the absence of such effects; for the person in whom the symptoms have manifested themselves may have partaken of some dish or part of a dish, or of some wine or drink which the others may not have tasted.

The attack of several persons by severe symptoms at or about the same time, and soon after a meal of which all have partaken, may be considered as the strongest possible presumption of poisoning either by the food itself, or by some accidental or intentional admixture. If the symptoms are those of simple irritant poison, it will not be possible to determine by the symptoms alone which alternative is the true one; but they may happen to be so characteristic as at once to point to the very poison which has been administered.

The value of this coincidence will be felt to be very considerable if it is borne in mind that none but epidemic diseases of the more severe kind are likely to attack several persons at the same time. It may be doubted even whether Asiatic cholera, in any one instance, has seized two or more members of a family so nearly at the same time, and at the same interval after a meal of which they had all partaken, as to give rise to a suspicion of poisoning. The only other diseases which are known to occur simultaneously, or at about the same time in severel persons, are imitative convulsive disorders; and these are generally confined to females.

The simultaneous fatal attack of several persons in the same place, or on the same mission, in the absence of any proof that they had partaken of the same food, would furnish a strong presumption of poisoning. Thus, the death in one night of four of the eight peers selected to represent the Scottish nation at the nuptials of Queen Mary with the Dauphin of France, in 1558 (Lord Fleming at Paris, Bishop Reid, the Earl of Rothes, and the Earl of Cassilis at Dieppe) very naturally gave

rise to a suspicion of poisoning; especially as the refusal of the Scottish deputies to grant the crown matrimonial to the bridegroom had given great offence to the French court.*

A suspicion of poisoning is often successfully rebutted by reference to the fact, that neither food, drink, nor medicine has been taken for hours before the commencement of an illness.† It must not, however, be too hastily assumed that, because no food or medicine was swallowed before the symptoms set in, those symptoms are not due to poison; for poisons have been introduced into the anus or vagina, poured down the throat of a drunken or sleeping person, or inserted into the external ear.

The rapid course of the symptoms towards a fatal termination is also an extremely fallacious evidence of poisoning; for many cases of poisoning end fatally after a considerable interval, and many acute diseases run a very quick course.

All the characters now mentioned are, therefore, to be received with caution, and carefully weighed against each other. The joint occurrence of two or more of them would strengthen the probability; and the coincidence of all of them, though not decisive, would justify a strong suspicion. Thus, if a person in perfect health, soon after taking food, were attacked with severe and continued vomiting and purging, and died within twenty-four hours, a strong suspicion would naturally arise that the food had contained some poisonous substance; and the suspicion would be greatly strengthened if other persons who had partaken of the same food were similarly affected. The poison might have been added to the food, or the food itself might have had poisonous properties; but the probability of poisoning in one of these two ways is very strong; and the inference would be almost irresistible if it could be shown that the person affected had never suffered in the same way before, and that neither English nor Asiatic cholera was prevailing at the time.

2. *The Post-mortem Appearances.*— The evidence from post-mortem appearances is, as a general rule, even less decisive than that afforded by the symptoms. It is true that there are poisons which leave in the dead body unmistakeable signs of their action; such as the mineral acids which stain and corrode the parts with which they come into contact, and oxalic acid in strong solution which corrodes the lining membrane of the gullet and stomach. Very characteristic appearances are also sometimes produced by corrosive sublimate, which, being decomposed by the secretions and membrane of the stomach, leaves a slate-coloured deposit of finely divided mercury; and by arsenious acid, which is changed into the yellow sulphide by contact with sulphuretted hydrogen, the product of putrefaction, or clings as a white patch to the mucous membrane. Orpiment, and Scheele's green, and the salts of copper, also leave characteristic stains.

* Sharpe's Peerage—Marquis of Ailsa.

† For illustrations see Christison 'On Poison,' p. 53.

Vegetable poisons are also sometimes identified by seeds, or fragments of leaves left in the alimentary canal.

Other poisons, again, belonging both to the class of irritants and to that of the narcotico-acrids, excite so intense an inflammation in the mucous membrane of the stomach and intestines as to give rise to a strong suspicion; such intense inflammation being of rare occurrence in disease. Less degrees of inflammation being of common occurrence in persons who have died a natural death, would not of themselves justify a suspicion of poisoning; and the same remark applies to those appearances of congestion in the brain which often result from the action of the narcotics and narcotico-acrids, such congestion being of common occurrence in simple apoplexy, in uræmia, and in many forms of death not originating in the brain.

The negative evidence from post-mortem appearances has the same force with the positive evidence. Thus the absence of corrosion in alleged cases of poisoning by corrosives would serve to disprove the charge; the absence of inflammation, after the alleged administration of an irritant or narcotico-irritant poison, to render the charge highly improbable; and the absence of congestion of the brain, in a case of imputed narcotic poisoning, would afford a lower presumption against the exhibition of such a poison.

Formerly undue importance was attached to an unusual blackness or lividity of the skin as evidence of poisoning; and the same remark applies to the early occurrence of putrefaction. There is no reason to believe that either of these appearances is more common after death from poisoning than after other forms of sudden death; and it is now well known that some of the mineral poisons, for instance arsenic and corrosive sublimate, preserve the parts with which they are in contact.

The discovery of post-mortem appearances similar to those produced by poison, even though confirmed by the discovery of the poison itself, would not prove that death has been caused by poison, for death might be produced by some other cause before the poison had had time to prove fatal. On the other hand, in several instances on record, a dead body has borne marks of severe external injury, or the internal organs have been found very extensively diseased, and yet the real cause of death was poison. This class of cases strongly enforces the caution insisted on at page 205, under the head of post-mortem inspection, viz., to submit every part of the body to careful examination.

The absence of characteristic post-mortem appearances might become important in the very improbable event of poison being introduced into the body after death, with a view to inculpate an innocent person.

The post-mortem appearances, then, do not furnish independent evidence in the case of any considerable number of poisons; but they may serve to confirm, by their presence, the presumption drawn from symptoms or from moral evidence, or by their absence they may invalidate a charge prompted by malice.

3. *Experiments on animals.*—There are many considerations which affect the value of the evidence derived from this source. Poisons are alleged not to produce the same effect upon animals as upon the human subject, and many examples of this difference have been put on record. They also require to be given in quantities altogether disproportionate to the difference of size. To this objection there is the obvious answer, that the animals generally selected for experiment, especially the dog and cat, have been proved to be similarly affected with man by all the poisons in common use.

This observation obviously applies with equal force to that very numerous class of cases in which the domestic animals and poultry have partaken of poisoned food in common with man, or have eaten the matters rejected from the human stomach.

It ought also to be borne in mind, that, in many instances of experiments on animals with substances supposed to contain poison, the speedy death of the animal, or its escape with impunity, affords sufficient evidence in the affirmative or negative, without minutely examining the symptoms actually present.

In the case of some poisons also, as, for instance, of strychnia, the effect is of that simple and marked kind, that it is likely to be present in all animals alike.

In many cases again, both experimental and accidental, this objection has been obviated by the poison having produced similar fatal effects upon more than one kind of animal, such as the dog, the cat, and the domestic fowl.

Another objection to the evidence drawn from experiments on animals, applies to those cases in which the substance administered has been previously rejected from the human stomach, or collected from the stomach and intestines after death. It is alleged that the animal secretions may be so vitiated as to prove poisonous, and the allegation is supported by the well-known experiment of Morgagni, made with bile taken from the stomach of a child who died in convulsions from tertian ague. The bile mixed with bread and given to a cock caused convulsions and death in a few minutes, and the same effect followed in two pigeons inoculated with this same substance. It is obvious that such an experiment as this made with the bile of a diseased subject can have no proper application to cases in which food rejected from the stomach of a healthy person under the influence of poison has been swallowed by animals and proved fatal.

It is scarcely necessary to state that experiments with substances rejected from the stomach, or found there after death, may fail in consequence of the substances themselves not containing the poison, or from the poison having been decomposed, or previously rejected.

In some cases of poisoning of animals by arsenic and by strychnia, good evidence of poisoning has been afforded by the fatal effect produced on one animal by eating the flesh of another animal which had been poisoned.

When there is reason to believe that the quantity of poison contained in the matters to be submitted to experiment is small, small animals, such as rats or mice, should be chosen for the purpose; and the frog has been lately recommended as particularly adapted to experiments with minute quantities of such poisons as strychnia. Leeches have also been pointed out as applicable to the same purpose.

In experimenting on larger animals which vomit their food, it is expedient to guard against the rejection of the poison from the stomach by securing the gullet with a ligature.

In the case of the greater number of poisons the necessity of experiments on animals is altogether superseded by the much higher certainty which attaches to chemical analysis; but as the tests for some of the vegetable poisons are uncertain, such experiments, performed with care, are valuable, and have been admitted as evidence.

Experiments on animals have also been resorted to, in order to determine some physiological questions raised in cases of poisoning; such as, the shortest time within which a dose of prussic acid may prove fatal, or the possible absence of marks of inflammation in the stomach after poisoning by some substance, such as corrosive sublimate, which usually occasions well-marked post-mortem appearances.

4. *Chemical Analysis.*—This form of evidence, though not absolutely necessary when the symptoms, post-mortem appearances, and circumstantial evidence confirm each other, is always of the first importance. The poison may be discovered in the living person by tests applied to the urine, to the blood abstracted by bleeding, cupping, or leeches, or to the serum of a blistered surface; or it may be detected in the dead body in the blood, flesh, viscera, and secretions. In both these cases the discovery of the poison affords conclusive evidence of its administration. The discovery of a poison in the substances rejected from the stomach or voided by the bowels, or in the contents of the stomach and bowels after death, or in articles of food or medicine of which the sufferer has partaken, is open to certain objections presently to be mentioned.

Objections may be urged against the sufficiency of the evidence drawn from chemical analysis on each of the three suppositions, that poison has been detected, that it has not been detected, or that it has been found in very small quantity.

On the supposition that a poison *has been found* in the matters discharged during life, or found in the alimentary canal after death, or in articles of food or medicine, there is the one objection, that it may have been accidentally mixed with it, or fraudulently, in order to inculpate an innocent party, in which case the evidence must be supported by proof that this could not have happened.

On the supposition that a poison *has not been found* in any of the substances submitted to analysis, it does not follow that a poison has not been taken; for in the case of a meal actually containing poison, and being followed by symptoms of poisoning, the articles submitted to

analysis may not contain the poison, though some other portion of the meal may have been adulterated with it. The poison may even be so unequally distributed through a single dish that the part examined may not contain any poison, though other parts of it do. Thus, the poison may be in the gravy, and not in the meat itself, or it may be sprinkled only on the outside of the joint. Again, when we are seeking for a poison in the contents of the stomach and intestines, we may fail to detect it because it had been rejected, or evacuated, absorbed, decomposed, or evaporated; or because it belongs to that large class of vegetable poisons which we have not yet found the means of discovering with certainty. The poison is most likely to be rejected or evacuated when it belongs to the class of irritants, absorbed when it is in a fluid state or soluble, decomposed when it belongs to the animal or vegetable kingdom. Insoluble substances, or those that are sparingly soluble, such as arsenic, may often be detected in the stomach and intestines after repeated vomiting and purging, for they adhere as powder to the mucous coat, and are enveloped by the tenacious secretion thrown out about them in consequence of the inflammation to which they give rise.

In cases of disinterment, poison, though it may have been the cause of death, and may have existed in the body at the time of death, may exude through the textures, or be evaporated, or so completely decomposed, that no trace of it is to be found. This observation does not apply to the mineral poisons, in a solid form, for though they may undergo change in consequence of the decay of the textures, they are merely transformed but not destroyed. Thus arsenious acid may combine with the nascent sulphuretted hydrogen given off during the decomposition of the stomach, and be converted into the yellow sulphide of arsenic, and corrosive sublimate may by the mere contact of the mucous membrane be converted into calomel, or pure finely divided mercury. Among the animal poisons, cantharides, and, among vegetable poisons, opium, may be mentioned as undergoing little change from the decay of the textures.

It is scarcely necessary to add that cases are by no means of rare occurrence in which malicious or mistaken imputations of poisoning are cleared up by the non-discovery of poison in the matters supposed to contain it.

When poison has been discovered *in very small quantity*, the objection is sure to be advanced that the quantity found was not sufficient to account for death. To this objection there is the obvious reply that the quantity of poison found must always fall short of the quantity actually taken: for it is only a part of the matters vomited or otherwise expelled from the body, of the contents of the alimentary canal after death, or of the blood tissues or viscera of the body which is submitted to analysis. The discovery, therefore, of a quantity of poison insufficient to destroy life is scarcely even a presumption that the substance was not administered in a poisonous dose; but it is also

consistent with the supposition that the poison was given in a medicinal dose or doses, for purely medical purposes.

But the value of chemical analysis as an evidence of poisoning is not limited to the discovery of the poison in larger or smaller quantity in some single substance submitted to examination; for by the comparison of one analysis with another, important light is sometimes thrown upon the manner of administration, and means are afforded of demonstrating the innocence or guilt of a suspected or accused party. An interesting case given by Christison on the authority of Dr. Alison will serve to illustrate this position. A bowl of porridge eaten by the deceased female for breakfast was found to contain arsenic. The chemical analysis showed that the poison was not mixed with the store of meal, but only with the portion of meal used in making the porridge. As it appeared from other circumstances that the poison must have been mixed with the meal in the morning before any stranger entered the house, the husband (the only other inmate) was convicted of the murder. An instance of an opposite kind is quoted by the same author from Barruel. The arsenic was found mixed with a large mass of flour, as well as with the part used in making bread. As the poison was not likely to have been mixed with a criminal intent, with so large a portion of the flour, the admixture was inferred to have been made with some innocent purpose. The wheat had probably been intended for seed, was mixed with arsenic to destroy insects, and had been sent, in mistake, to the mill.*

In several cases of poisoning by the corrosive acids, the examination of the clothes of the suspected murderer conjointly with the body of his victim has led to a conviction.

The cases just referred to are examples of qualitative analysis. The two following cases illustrate, in an equally striking manner, the use which may sometimes be made of two or more analyses directed to determine the quantity of poison present in the several substances submitted to examination.

Mr. Hodgson, a surgeon, was tried at Durham Autumn Assizes, in 1824, for attempting to poison his wife. It was proved that he had substituted corrosive sublimate for calomel and opium in pills prescribed by her physician. This he attributed to a mistake committed while he was intoxicated. It was further proved that a laudanum draught, also ordered by her physician, contained corrosive sublimate. This, too, the prisoner explained by alleging that he had mistaken for the water-bottle an injection of corrosive sublimate which he had previously prepared for a sailor. But on submitting the draught and the injection to chemical analysis, the former was found to contain fourteen grains to the ounce, while the latter contained only five grains to the ounce.†

* Christison 'On Poisons,' p. 75.

† For a full report of this interesting case see the 'Edin. Med. and Surg. Journal,' vol. xxii. p. 438.

Samuel Whalley was indicted at York Spring Assizes, in 1821, for maliciously administering arsenic to Martha King, who was pregnant by him. But it appeared that of the tarts in which the arsenic was alleged to have been administered, the portions eaten could not have contained more than ten grains, while the matters alleged to have been vomited, contained even after repeated attacks of vomiting, fifteen grains.*

5. *The conduct of suspected persons.*—Great importance is very properly attached, in trials for poisoning, to the conduct of the prisoner, before, during, and after the illness of the deceased. The prisoner is often proved to have become possessed, without adequate motive, of a knowledge of poisons and their properties; to have purchased poison under false pretences; to have compounded medicine, or prepared food for the deceased; to have sought opportunities of administering medicine or food; to have shown great haste in disposing of matters which might have been examined; to have placed obstacles in the way of obtaining proper medical assistance; to have made arrangements for keeping near relatives, and other inconvenient witnesses at a distance; to have made hurried arrangements for the funeral; to have made opposition to an examination of the body; perhaps to have tampered with the matters reserved for analysis. Such acts as these, some of which are likely to fall under the notice of a medical attendant, will have to be carefully weighed by the jury, together with such other items of general or circumstantial evidence as the existence of an obvious motive or inducement to the crime, and the previous state of mind of the deceased as affording a probability, or the reverse, of suicide.

This part of the subject of death by poison may be usefully brought to a close by a summary of the leading precautions to be observed in conducting medico-legal examinations in cases of suspected poisoning.

RULES FOR MEDICO-LEGAL EXAMINATION IN CASES OF POISONING.

The chief points to be attended to in cases of suspected poisoning are the following:

1. The state of the patient before the commencement of the symptoms, whether in good health or suffering from illness—the time at which the symptoms began, and at what interval after a meal, or after taking food, drink, or medicine—the nature of the symptoms, their order and time of occurrence, and the period of the commencement of any new symptom or train of symptoms; whether the symptoms increased steadily in severity, or alternated with intervals of ease, and whether the exacerbations corresponded with a repetition of the food or medicine, or followed the use of any new article of food or medicine—also the character of any substances which may have been rejected from

* 'Edin. Med. and Surg. Journal,' vol. xxix. p. 19.

the stomach, or have passed from the bowels. If the case terminated fatally, the exact time of the death should be noted down. If the person is found dead, the time at which he was last seen alive should be ascertained.

2. When the symptoms of poisoning have shown themselves soon after a meal, minute inquiries should be made as to the manner in which the several dishes used at the meal have been prepared; the vessels used in the preparation of the food should be inspected, and their contents, if necessary, be preserved; suspicious powders or liquids found in the house should also be sealed and kept. If several persons have partaken of the same meal care should be taken to ascertain what articles were taken by those who suffered, and by those who escaped, and in what quantities, and whether the same articles of food had been previously taken without any bad effect by the persons attacked.

3. The vomited matters must be carefully collected, and removed from clothing, furniture, &c., on which they may have been rejected; and portions of the dress, furniture, or flooring may, if necessary, be reserved for examination.

4. In performing a post-mortem inspection, a note should be kept of the time at which the inspection is made, and all the precautions insisted on (p. 205) should be carefully observed. The state of all the internal viscera must be noted, and especially of the mouth, tongue, and fauces, of the larynx, œsophagus, stomach, and intestines. In removing the viscera, care should be taken to place them on a *clean* surface, and to preserve them in *clean* vessels, and the same caution applies to the contents of the stomach and intestines. If the medical man has occasion to transmit the contents of the stomach and bowels, the blood, or other fluids of the body, or portions of the viscera, or other substance supposed to contain poison, to a chemist for analysis, it must be carefully sealed, so as to prevent the possibility of the substance being tampered with during its transit.

5. In performing a chemical analysis, measures should be taken to preserve the identity of the substances submitted to examination. While the analysis is going forward they must not be let out of the sight and custody of the operator, and during his absence they should be preserved under lock and key.

6. In conducting correspondence in reference to pending medico-legal analyses, letters should be doubly secured first by wafer or gum, and then by seal; and letters should be posted, if possible, by the writer.

CLASSIFICATION OF POISONS.

There are only two principles of classification which commend themselves to the judgment of the toxicologist, as logically correct and practically useful. The one arranges the several poisonous agents

according to the source whence they are obtained; the other, in accordance with their action on the system. When the first principle of classification is adopted, poisons are arranged in three principal classes—mineral, vegetable, and animal; when the second is preferred, they are also arranged in three leading classes—irritants, narcotics, and narcotico-acrids. A classification based solely on the source from which the poison is obtained is open to the very obvious objection that though almost all the substances derived from the mineral and animal kingdoms are irritants, those derived from the vegetable kingdom comprise poisons belonging to each of the three classes, the irritant, narcotic, and narcotico-acrid. On the other hand, a classification based on the mode in which poisons affect the system is subject to the inconvenience of separating, in the case of the considerable class of vegetable poisons, substances derived from the same kingdom of nature, and distributing them through the three classes of irritants, narcotics, and narcotico-acrids.

As, then, these two modes of classification are open to nearly equal objection, on the ground of logical consistency, our choice will naturally be determined by considerations of utility; and it is obvious that these greatly preponderate in favour of an arrangement which places side by side those poisonous substances which produce a similar effect upon the system.

The most useful classification of poisons, therefore, is that founded on their mode of action, and this is the one now generally adopted. According to the received classification, poisons may be distributed into three principal classes—*irritants*, *narcotics*, and *narcotico-irritants*. The poisons belonging to the first class excite inflammation in the parts with which they come in contact, and give rise either to the constitutional disturbance which attends on high inflammatory action, or to the nervous symptoms attendant on severe and extensive injury to important organs of the economy; those belonging to the second class affect the nervous centres, producing coma, delirium, convulsions, and other allied symptoms; and those of the third class combine, in varying degrees and proportions, the symptoms proper to the two classes.

After a careful consideration of the many and conflicting difficulties which surround the attempt at a classification of poisons, I see no reason to depart from the division into irritants, narcotics, and narcotico-acrids. Distinct chapters will be devoted to these three leading classes, in which chapters the several poisons belonging to each class will be distributed into sub-classes, in accordance chiefly with their mode of action.

The relative importance of the three classes of poisons may be inferred from the number of cases in which, one year with another, they prove fatal. In the five years, 1852—56, the number of deaths by poison amounted, on an average, to 401, of which 133 were due to poisons not distinctly specified. Of the remaining 268, 90 were

irritants, 175 narcotics, and 3 narcotico-acrids. 82 cases of suicidal poisoning were distributed as follows:—Irritant poisons, 27; narcotic poisons, 54; narcotico-acrid poisons, 1. It appears, then, that two deaths by narcotic poisons occur for one death by the irritants, while deaths by narcotico-acrid poisons are of comparatively rare occurrence. The principal poisons, arranged in the order of the frequency with which they prove fatal, take rank as follows:—Laudanum, opium, morphia, and Godfrey's cordial, 141; prussic acid, essential oil of bitter almonds, and cyanide of potassium, 34; arsenic, 27; salts of lead, 23; mineral acids, 15; oxalic acid, 13; mercury, 10; strychnia and nux vomica, 2.*

* 'Nineteenth Annual Report of the Registrar-General,' p. 164.

CHAPTER II.

IRRITANT POISONS.

SUBSTANCES which inflame the parts to which they are applied are said to act as irritants to those parts; and substances which, in traversing the alimentary canal, inflame the organs with which they come in contact, are also termed irritants; and, with the exception indicated when defining the term *poison*, of hot and cold water, and such articles as pins, needles, and powdered glass, may claim to be admitted into the list of irritant poisons, if they prove in any instance fatal to life, or productive of symptoms of great severity.

The class of irritants comprises animal, vegetable, and mineral substances; it contains a greater number of individual poisons than the two other classes of narcotics and narcotico-acrids put together; and it also contributes largely to the list of cases of poisoning. It accounts for one-third (90 in 268) of the annual deaths from ascertained poisons; of which third more than two-thirds (61 in 90) were metallic irritants, one-third (27 in 90) mineral and vegetable acids (principally the sulphuric and oxalic), while all the remaining irritants formed but an insignificant fraction of the whole.

So considerable a class of poisons must needs comprise several sub-classes. Three groups, at least, admit of distinction and separation. There is the well-marked group of simple corrosive poisons, which destroy life by a direct destructive action on the mucous membrane of the alimentary canal; the equally well-marked group which proves fatal by the irritation occasioned in the same parts; and a third group which add to local destruction or irritation, peculiar remote effects not due to the local injury they inflict. To the first group belong the mineral acids, the caustic alkalis, and their carbonates, oxalic acid when given in strong solution, and the more soluble salts of the metallic poisons, mercury, antimony, zinc, and tin. To the second group belong the principal vegetable irritants, some of the alkaline salts used in medicine, and the less active metallic poisons. The third group comprises oxalic acid and the soluble oxalates; the metallic irritants, arsenic, mercury, antimony, lead, and copper; the metalloidal elements, phosphorus, and iodine; and, as a product of the animal kingdom, cantharides.

Any classification based solely upon the mode of action of these poisons must recognize these three classes; but as great inconvenience would arise from separating oxalic acid from the other vegetable acids,

or corrosive sublimate from the less soluble and non-corrosive salts of mercury, a mixed arrangement, recognizing mode of action, on the one hand, and similarity of composition and origin on the other, will best meet the practical requirements of the case. Such a mixed arrangement is given at the end of the present chapter.

The *symptoms* caused by irritant poisons, as a class, are burning pain and constriction in the throat and gullet; acute pain, increased by pressure, in the pit of the stomach; intense thirst; nausea and vomiting, followed by pain, tension and tenderness of the entire abdomen; and purging attended with tenesmus, and frequently with dysuria. The constitutional symptoms vary with the intensity of the irritation, and the interval which has elapsed since the administration of the poison, being at one time those of collapse, at another of inflammatory fever. The mode of death also varies. The patient does not rally from the first shock to the nervous system, or he dies in strong convulsions, or he is worn out by protracted suffering, or he is starved through the injury sustained by the gullet and stomach.

These symptoms vary in severity, and in the period and order of their occurrence, with the quantity of the poison, with its solubility, and with the full or empty state of the stomach; but in a more marked manner, according as it is corrosive or simply irritant. When the poison is sparingly soluble, as in the case of arsenious acid, the pain in the several parts specified is not felt immediately on swallowing it, but after an interval more or less considerable, and, occasionally, the pain and sense of constriction in the throat and gullet are absent; or they follow the other symptoms instead of preceding them, in consequence partly of the frequent acts of vomiting, and partly of the repeated contact of the vomited matters with the upper portions of the tube; but when the poison is corrosive, and very soluble, as is the case with the mineral acids, oxalic acid, the pure alkalis, corrosive sublimate, and the chlorides of tin, zinc, and antimony, the pain is felt as soon as the poison comes in contact with the parts affected, and occurs almost simultaneously in the throat, fauces, gullet, and stomach, whence it extends rapidly to the entire abdomen, and is soon followed by vomiting and purging. The action of the corrosive and more soluble irritant poisons is also followed by copious vomiting and purging of blood, which does not take place at all, or to a more limited extent, in the case of the simple irritants. In poisoning by the corrosives, also, the upper part of the windpipe is frequently attacked with inflammation, giving rise to hoarseness, wheezing respiration, and harassing cough, and often ending in suffocation.

The Morbid Appearances caused by the irritants are those of corrosion, followed by inflammation and its consequences, when the poison is a corrosive, and those of inflammation and its consequences when the poison is a simple irritant. The corrosions may be confined to small spots, or they may extend over a large surface; they may be limited to a removal of portions, more or less considerable, of the lining mem-

brane of the gullet and stomach, or all the coats of those organs may be destroyed. The parts injured may become the seat of perforations of greater or less extent, and considerable portions of the organs themselves may even be discharged by vomiting or by stool.

The simple irritants, and the corrosives beyond the corroded part, give rise to inflammation more or less severe, followed by its usual consequences. In some cases there is merely increased vascularity, in others deep redness; the surface is covered with a tenacious secretion, and the cavity filled with a glairy mucus. The coats are found thickened with the intensity of the inflammation; dark, as if gangrenous, from the extravasation of blood into the mucous membrane and beneath the submucous tissue; softened; but occasionally hard and shrivelled. Vessels filled with dark blood are sometimes found ramifying minutely over the surface, which in other instances is studded with black points. Sometimes the mucous membrane is found ulcerated, and more rarely it is gangrenous. These appearances are not confined to the stomach, but are found in the fauces, and œsophagus, and in the duodenum. The appearances in the rest of the small intestines are those of acute inflammation, with ulceration and softening of the mucous membrane; ulcers are also found in the large intestines, and excoriation of the anus. In some cases there are traces of inflammation in the mucous membrane of the larynx and air passages; and the corrosive poisons often produce in the gullet a peculiar wrinkled and worm-eaten appearance, due to the contraction of the longitudinal and transverse fibres, and the removal of patches of epithelium. (See figures 12, 13, and 14, p. 338.)

The *treatment* of poisoning by the irritants as a class consists (irrespective of the administration of the appropriate antidote) in the prompt use of the stomach-pump (if not contraindicated by extensive destruction of the soft parts), or of emetics of ipecacuanha, common salt, or mustard, assisted by copious draughts of warm water, and by tickling the fauces; and, when the poison is discharged, by the free use of milk and water, or of oily and mucilaginous drinks. Castor-oil mixed with milk is the best aperient. The after-treatment must be determined by the state of the patient and the special symptoms present in each case. Bleeding, if indicated by the state of the patient, is to be commended as removing part of the poison absorbed into the blood.

Several of these symptoms and post-mortem appearances are not peculiar to poisoning; and there are some common and familiar diseases, as English and Asiatic cholera, acute inflammation of the stomach or intestines, rupture of the stomach or intestines, or of other viscera of the abdomen, in which one or more of the symptoms of irritant poisoning are present in a marked form. They may also be produced by drinking hot or cold water; and authors have been at some pains to show that simple distension of the stomach, vomiting and purging of blood, colic, strangulated hernia, and obstruction of the bowels, diarrhœa, and dysentery, have some symptoms in common with ordinary cases of irritant poisoning, and may still more nearly resemble certain excep-

tional cases. Though the importance of the objections founded on this possible resemblance of disease to poisoning has certainly been exaggerated, it may be well to point out some of the leading features in which the diseases in question differ from the usual effects of irritant poisons.

In *English cholera*, the evacuations very rarely contain blood, and there is no pain and constriction in the throat, except occasionally as the result of constant efforts to vomit. The disease prevails chiefly in summer and autumn, and is rarely fatal. In *Asiatic cholera*, too, discharge of blood is a very rare occurrence, though the evacuations sometimes have a port-wine tint; and the pain and constriction of the throat are wanting. In both diseases the purging follows the vomiting much more rapidly than in cases of poisoning. The irritant of which the operation most nearly resembles these diseases is arsenic; and during the prevalence of both forms of cholera the effects of arsenic have been mistaken for disease, without seriously affecting the reputation of the medical attendant. *Acute inflammation of the stomach*, except as the result of drinking hot or cold water, or as the effect of some irritant substance, is a very rare disease, and is not accompanied either by pain and constriction in the throat, or by diarrhœa. *Acute inflammation of the bowels* affects their peritoneal covering, and is attended with constipation. *Distension of the stomach*, though an occasional cause of severe suffering and of sudden death, does not admit of being mistaken for the effect of a class of poisons of which vomiting is a leading symptom. A full stomach would, in itself, furnish a strong presumption against irritant poisoning. *Rupture of the stomach* occurring, as it often does, during or directly after a meal, and through an effort to vomit, followed by sudden and violent pain, by collapse, and by death instantly, or in from four or five to less than twenty-four hours, might naturally raise a suspicion of poisoning, which nothing short of a post-mortem examination can set at rest. The same observation applies to a rupture of the inner coat alone—a case of very rare occurrence—and to *rupture of the intestines, and of the other viscera of the abdomen.* All these accidents may be followed by vomiting, with excruciating pain, and extreme tenderness of the abdomen, cold skin, feeble pulse, and symptoms of collapse, with death within twenty-four hours. The effect of drinking *hot water* differs from that produced by the simple corrosives, chiefly in the absence of characteristic stains, and the negative result of an analysis. The drinking of *cold liquids* sometimes causes vomiting and purging, and other symptoms allied to those of irritant poisoning; and, in the absence of a complete history of the case, it may be necessary to resort to the negative evidence afforded by the result of an analysis.

Of *vomiting and purging of blood* it will be sufficient to remark that they are not accompanied by urgent symptoms suggestive of the action of poison; of *diarrhœa* and *dysentery* that, in by far the greater

number of cases of poisoning discharges from the bowels are associated with vomiting; and of *colic, strangulated hernia*, and *obstruction of the bowels*, that they are attended by constipation, and that the vomited matters are often feculent.

The *post-mortem appearances* in cases of irritant poisoning are not always characteristic; and it is true of the more common appearances, as of some of the more usual symptoms, that they might have been occasioned by disease. The appearances in the stomach commonly specified as answering to this description are—Redness of the Mucous Membrane; Gangrene and Lividity; Softening; Ulceration; and Perforation.

Redness of the mucous membrane may be produced by colouring matter; but when it is due to blood contained in the vessels, it may be traced to subsidence of the blood after death, or to the blood being driven into the small vessels by the contraction of the arteries, or to transudation through the peritoneal covering of the liver or spleen; or to congestion in cases of sudden death, especially in the various forms of death from apnœa, when it often occurs in large bright patches; or lastly, it may be the result of that flow of blood to the mucous coat of the stomach which takes place during the process of digestion. Sometimes, too, a remarkable redness of the stomach is found after death without any symptoms occurring during life to account for it. Hence, mere redness of the mucous coat of the stomach, even when it does not occur on the most depending part, is not to be regarded as a proof of inflammation. But when the redness of the mucous membrane is combined with softening, putrefaction not having set in; when the membrane itself is covered with a thick and tenacious mucus; when it is opaque, so that dissected off and stretched over the finger, the finger is not visible; the redness may be certainly attributed to inflammation, especially if it cannot be traced to mere subsidence of blood, and the larger veins are not injected. The same remarks apply also to the intestines.

Gangrene and Lividity.—Gangrene of the mucous membrane is of very rare occurrence, except as the consequence of long-continued pressure in cases of hernia. Gangrene of the mucous membrane from acute inflammation has been described by authors of reputation; but there is no doubt that a dark appearance due to infiltration of blood into its texture has been often confounded with it. This lividity of the mucous membrane presents itself in as many shapes as the redness just described; in points, striæ, ramifications, and patches of greater or less extent. In some instances the vessels, to their smallest branches, are filled with black blood; in others, the mucous membrane is thickly studded with black points; and in others, again, thick coagulated blood is poured out into the sub-mucous cellular membrane. These appearances, but especially the latter, are most common in poisoning by the mineral acids and by oxalic acid. There is reason to believe that these appearances (with the exception of the injection of

the vessels with dark blood, which is sometimes seen in post-mortem softening) are never found in the stomach as the result of disease, but that they are always due to the action of violent irritants. They are, however, sometimes met with in the intestines in acute dysentery and enteritis. This livid colour of the mucous membrane is distinguished from melanosis by the latter being arranged in regular well-defined spots, without thickening of the mucous membrane, or signs of surrounding inflammation.

Softening.—The mucous membrane is sometimes softened, sometimes hardened by the action of poisons. When softened, it is either through the action of the corrosives, or it is the effect of inflammation without corrosion. Softening is also one result of disease during life, and of the action of the gastric juice after death. As the softening from corrosion is attended with more complete destruction of surrounding parts, with characteristic changes of colour, and with signs of acute inflammation, and as the softening due to the action of the non-corrosive irritants is attended by marks of acute inflammation, the softening due to these two causes will be readily recognized; and the fact that the softening from disease is not preceded by any characteristic symptoms will sometimes assist the diagnosis.

Ulceration.—Ulcers of the stomach may arise either from the action of poison, or from disease. Those due to disease are either the result of cancer of the stomach, which is readily recognized, or they occur in stomachs which, in other parts, present a healthy appearance. Open ulcers, or the scars of ulcers, are present in about one dead body in ten. In about one-fifth of the cases there is more than one ulcer. The ulcer is rarely much smaller than a fourpenny piece, or larger than a crown-piece, but it may attain a diameter of five or six inches. Its shape is usually round or oval; and it presents the appearance of a shallow but level pit, with a sharp, smooth, vertical edge, as though it had been punched out; and as the circular opening in the submucous areolar tissue is smaller, and the aperture in the peritoneum, if the ulcer perforates, still more minute, the ulcer has the appearance of a cone, with the base directed inwards. The mucous membrane and the areolar tissue are somewhat thickened by exudation of lymph; and it is not unusual to find adhesions to surrounding parts. In some cases there is little or no appearance of inflammation in the parts surrounding the ulcer; in most instances the edges are thickened and raised, and the thickening sometimes extends to a circle of half an inch or an inch; and occasionally the surrounding parts are described as "a thick brawny mass," sometimes mistaken for cancer; or they are stated to be blackened. In more than a third of the cases the ulcer occupies the posterior surface of the stomach, and more than three-fourths of the ulcers occur on the posterior surface, on the lesser curvature, or near the pylorus.* When due to poison the ulceration

* See Dr. Brinton, 'On the Pathology, Symptoms, and Treatment of Ulcer of the Stomach,' p. 4.

is the result of a more intense inflammation than that which attends the more chronic ulceration of disease; and the ulcer is often found discoloured, as in the case of nitric acid and iodine, or covered with a white powder, as in the case of arsenic, or coated with a substance resulting from the decomposition of the poison, such as the black powder (minutely divided mercury), formed by the decomposition of corrosive sublimate, or the yellow sulphide of arsenic formed during the process of putrefaction after death. These occasional appearances, added to the intensity of the inflammation, and the symptoms during life, will render the distinction between idiopathic ulceration and that due to poisoning easy.

Perforation of the Stomach may arise, 1, from corrosion; 2, from inflammation, and consequent ulceration; 3, from softening during life; and 4, from the action of the gastric juice after death.

1. *Perforation from Corrosion.*—It is impossible to confound a perforation due to the direct *corrosive* action of an irritant poison with any perforation arising from natural causes, acting either during life or after death. The state of the mouth, throat, and gullet, and often of the skin and clothes of the deceased will render the distinction easy. In many cases, too, the corrosive poison escaping into the cavity of the abdomen leaves traces of its action on the other viscera.

2. *Perforation from Ulceration* is of very rare occurrence. When caused by idiopathic inflammation, the surrounding mucous membrane is less highly inflamed, and neither stained nor covered with deposit, as in poisoning by the irritants.

3. *Perforation from Softening* of the coats of the stomach during life is not of rare occurrence. It most frequently happens in young females, from fifteen to twenty-five years of age, and often after slight symptoms of indisposition. The rupture generally takes place soon after a meal, more rarely as a consequence of strong sudden exertion, and is immediately followed by acute pain of the abdomen, and symptoms of acute inflammation of the peritoneum. There is little vomiting, and no purging, but the patient dies in a state of collapse in from eighteen to thirty-six hours; but in some cases the fatal event is postponed in consequence of the escape of the contents of the stomach being small in quantity, and the inflammation of the peritoneum limited in extent, or subacute in character. The aperture in the peritoneum is generally small, and the ulcer itself has the peculiar characters just described. In one-third of the cases the seat of the perforation has been the lesser curvature of the stomach; in one-tenth, the pyloric extremity; in about one-twentieth the posterior surface; in the same number the cardiac extremity; while in one-eighth of the cases there are two ulcers opposite to each other on the anterior and posterior surfaces of the organ, the first being the seat of the perforation.*

The absence of marks of acute inflammation, and, in many cases, of

* Consult Dr. Brinton's work just cited, and Dr. Taylor's essay in the 'Guy's Hospital Reports,' No. 8.

the discolourations characteristic of some of the irritant poisons; the non-detection of poison in the stomach itself, or in the contents of the abdomen; the sudden occurrence of pain; the slight subsequent vomiting; the absence of diarrhœa; and the early occurrence of death, as compared with the period at which perforation following poison generally proves fatal, will make the distinction between this form of perforation and that due to poison easy.

4. *Perforation from the action of the gastric juice after death* has been the subject of much controversy; but the fact of its sometimes taking place has been placed beyond a doubt, by observations and experiments made both on men and animals. The seat of the opening is generally the posterior surface of the stomach, but it depends on the position of the body. The aperture may be of any size, from that of a shilling to that of the palm of the hand: and, in some instances, it has been found to occupy one-half of the stomach. It may assume any shape, and its edges are fringed, softened, and smeared with a dark pulpy mass, and the vessels of the stomach are sometimes found injected with dark blood. The viscera in contact with the opening sometimes undergo a similar change. Occasionally there is more than one aperture. As there is no appearance of inflammation around the opening, it is impossible to confound this post-mortem change with the effect of an irritant poison.

Perforation of the stomach due to the action of irritant poisons would be attended by marks of acute inflammation, and by characteristic stains and deposits.

Perforation of the *intestines* is of very rare occurrence in cases of poisoning, and perforation of the *gullet* still less common. Both are of occasional occurrence as the consequence of diseases not difficult to recognize after death.

CLASSIFICATION OF THE IRRITANT POISONS.

The following classification, which comprises all the more important divisions of irritant poisons, is in conformity with the principles already laid down in this chapter. It recognizes three leading classes, with numerous sub-classes—the leading classes being—1. Simple Corrosives. 2. Simple Irritants. 3. Specific Irritants.

1. The class of SIMPLE CORROSIVES comprises two sub-classes:—*a*. The mineral acids. *b*. The alkalis and their carbonates. These simple corrosive poisons are treated in two distinct chapters.

2. The class of SIMPLE IRRITANTS comprises:—*a*. The vegetable acids, of which the oxalic is the most important. This acid, though belonging to the class of specific irritants, is most conveniently included in the same chapter with the other vegetable acids. *b*. The salts of the alkalis and earths. *c*. Vegetable irritants in common use as purgatives. *d*. Other vegetable irritants not comprised in the fore-

going sub-classes; among which savin is the most important. *e.* Products of destructive distillation, such as dippels and fusel oil. *f.* Ergot of rye, and other diseased or decayed vegetable matters. *g.* Animal irritants, of which cantharides is the most important. *h.* Irritant gases.

3. The class of SPECIFIC IRRITANTS contains — *a.* Metalloidal poisons, iodine and its salts, and phosphorus. *b.* Metallic irritants, among which arsenic, mercury, antimony, lead, and copper, with their compounds and salts, are the most important.

CHAPTER III.

MINERAL ACIDS.

1. Sulphuric acid.
2. Nitric acid.
3. Muriatic acid.
4. Mixtures and compounds of these acids.

THE mineral acids, as a sub-class of the large class of irritant poisons, are distinguished from most irritants by their strong corrosive properties, and from all irritants except those of the next sub-class, alkalis and their carbonates, by their remote symptoms being due entirely to their energetic local action. They have no specific remote effects.

In the years 1837 and 1838 one in fifteen of the fatal cases of poisoning were due to the mineral acids, pure or in a state of mixture. The whole number was 36, of which 32 were from sulphuric acid, 2 from nitric acid, mixed in one instance with laudanum, in another with aloes. The number of cases of poisoning by these acids has probably decreased both absolutely and by comparison with other poisons; for in the five years 1852-1856, 77 cases only were registered, of which 73 were by sulphuric acid, 2 by nitric acid, and 2 by muriatic acid.

Though poisoning by the mineral acids is, for obvious reasons, not likely to be a homicidal act, they are sometimes administered to adults in place of medicine, or poured down the throat while they are asleep or intoxicated: and more frequently to young children by their mothers or nurses. In infants the act is most probably homicidal, in children either homicidal or accidental, in adults generally suicidal. The mineral acids have also been administered otherwise than by the mouth. One acid (the sulphuric) has been injected into the vagina, another (nitric acid) has been poured into the ear.

The mineral acids, especially oil of vitriol, are also sometimes used to disfigure the person, or destroy the clothes, or to imitate the destructive action of moths.

The Mineral Acids have the following familiar properties in common:—they discolour, and, at the same time, corrode, or injure, the texture of black cloth; and they redden vegetable blues, and alter or discharge the colour of articles of dress.

The *symptoms* common to the mineral acids are the following:—

a burning pain in the mouth, throat, and gullet, occurring *immediately* after swallowing the acid; followed by excruciating pain in the stomach, eructations, constant retching, and vomiting of a brownish or blackish matter containing blood, coagulated mucus, flakes of epithelium, or portions of the mucous membrane of the stomach itself. The act of swallowing is painful, or even impossible, and there is intense thirst. The bowels are costive, and the urine scanty or suppressed, and the patient is troubled with constant tenesmus and dysuria. The pulse is generally small and frequent, the respiration catching, and sometimes laborious, and the countenance expressive of intense anxiety. In some cases the acid passes into the windpipe, and causes a harassing cough, with croupy respiration, the accumulation of tenacious mucus discharged with difficulty, and a hoarse voice threatening instant suffocation. The lips are shrivelled and blistered, or excoriated, or they present spots of the characteristic colour of the acid bordered with red, or there are discoloured streaks extending from the angles of the mouth to the chin. The inside of the mouth is white, shrivelled, and corroded, and the teeth loose and discoloured. The tongue is sometimes white and polished, sometimes discoloured. The acid generally leaves distinct marks on the cheeks, neck, or fingers, as well as on the clothes; and the vomited matters, if rejected on a limestone pavement, cause effervescence. In fatal cases death is generally preceded by symptoms of collapse; the intellectual faculties remaining clear to the last. Sometimes the patient dies convulsed, sometimes suffocated. Severe nervous symptoms, such as trismus, tetanus, epilepsy, and delirium are occasionally present, and rashes sometimes appear on the skin.

The *period at which death happens* is very variable: it may take place as early as two hours, or at the end of days, weeks, or even months. When the patient survives for some days, the symptoms are somewhat modified. He is feverish; has a dry skin and frequent pulse; occasionally vomits his food and drink, mixed with flakes of tenacious mucus, similar flakes being sometimes discharged from the bowels; and suffers from salivation with fœtor of the breath. The belly is tense, the breathing short and difficult; there are pains and spasms of the limbs; digestion is impaired, all the functions of the body languish, the patient becomes extremely emaciated, and dies in a period varying from a fortnight to some months.

Other patients recover imperfectly, to become dyspeptic, and valetudinarians for life. Rather less than half the number of cases recover completely.

In some instances the poison does not reach the stomach, but affects the throat, gullet, and windpipe. In other cases the acid acts only on the windpipe, causing death by suffocation.

The mineral acids have also proved fatal when introduced into the body otherwise than by the mouth; as when injected into the bowels or womb, or poured into the ear.

The *post-mortem appearances*, common to the mineral acids, are the following:—The body externally has a healthy appearance. The lips, chin, and other parts of the body are marked by the action of the acid in the manner already described. The mucous membrane of the mouth is white, yellowish, or brownish, shrivelled and corroded; and the same appearances extend into the throat. The epiglottis is sometimes contracted, sometimes swollen, the rima glottidis contracted, and the larynx inflamed. The gullet either presents the same appearance as the mouth and fauces, or it is highly inflamed, and lined with a coat of tenacious mucus, or its mucous coat is partially or wholly stripped off. (See fig. 13, p. 338.) Sometimes it presents the peculiar wrinkled and worm-eaten appearance shown in fig. 12. Occasionally the gullet entirely escapes. In rare cases it becomes the seat of ulceration, and is perforated. The stomach is usually distended with gas, and filled with a yellowish, brownish, or blackish glutinous secretion, which also extends into the œsophagus and commencement of the small intestines. The mucous membrane is highly inflamed, its vessels are minutely injected with black blood; see fig. 14, p. 338, in which the black grumous matter and the black injected vessels are shown in a case of poisoning by hydrochloric acid, or the black blood is extravasated into its substance; the rugæ are softened, and extensive destruction of the coats of the stomach, ulceration, and perforation, are of frequent occurrence. The pylorus is commonly contracted. The duodenum presents similar appearances to those found in the stomach. When perforation takes place, the apertures are generally circular, situated at the posterior part of the organ, and surrounded by inflammation and black extravasation. The peritoneal surface of the viscera, even when there is no perforation of the stomach, is highly inflamed and coated with coagulable lymph. When the contents of the stomach escape into the cavity of the abdomen they act upon the surface of the viscera, and impart to it a peculiar unctuous feel. The inflammation sometimes extends into the chest, so that the thoracic surface of the diaphragm has been found coated with lymph. The blood in the large vessels is often found firmly coagulated. The urinary bladder is generally empty and contracted.

Exceptions to the general rule of the post-mortem appearances are numerous, partly arising from the strength and quantity of the acid, partly from the state of the stomach at the time, and partly from the part of the alimentary canal which the poison reaches. It may not pass beyond the mouth, it may not enter or pass the stomach, or its action may be limited to the upper part of the windpipe.

The *diagnosis* of poisoning by the mineral acids is easy. The *immediate* commencement of the symptoms, the extensive disorganization produced in all the parts with which the acids come in contact, the absence of diarrhœa, the stains on the skin of different parts of the body and on the clothes, form a combination not attributable to any other cause. In the great majority of cases, the symptoms on the

post-mortem appearances are decisive of themselves, but when combined they leave no room for doubt. In almost every instance additional evidence is afforded by the chemical analysis.

Treatment.—The best antidote is calcined magnesia, finely powdered and mixed with water, or milk and water. If this cannot be immediately procured, carbonate of magnesia, chalk, or whiting may be substituted; and, if these should not happen to be at hand, oil or soapsuds. The plaster from the ceiling or wall of an apartment, beaten into a thin paste with water may be substituted. The pure alkalis and their carbonates, being themselves corrosive poisons, should be given only in weak solution. Previous to the preparation of the antidote, and subsequently to it, milk, and mucilaginous and oily drinks should be given frequently and in large quantity, and should be continued for many days.

The use of the stomach-pump is contra-indicated in the corroded and softened state of the parts: indeed, it has often been found impossible to introduce it. If the patient is quite unable to swallow, a cautious attempt may be made to introduce the tube into the œsophagus beyond the obstruction. The subsequent treatment must depend on the nature and severity of the symptoms. Leeches to the pit of the stomach may be necessary, and sometimes blood will have to be taken from the arm. The bowels must be kept open at first by injections of thin gruel, and as soon as aperients appear safe, by castor-oil, previously mixed with about twice its quantity of hot milk. Excoriations on the surface must be treated as burns.

1. SULPHURIC ACID. (*Oil of Vitriol.*)

Sulphuric acid was the cause of death in one-seventeenth of the fatal cases of poisoning in 1837-38. It was the poison administered in 32 out of the 36 cases of poisoning by the mineral acids; of which 32 cases, 21 were accidental, and 7 suicidal, and 4 of a doubtful character. In the five years 1852-56 it is credited with 73 deaths, and it takes the fifth rank among the poisons in order of frequency of use.

The strong sulphuric acid is sold by druggists and oilmen as "oil of vitriol" to blacking-makers; and the dilute acid as "vitriol," "spirit of vitriol," or "essence of vitriol," for cleaning utensils of copper or brass, at the small charge of 1*d.* for four ounces, or 2*d.* or 3*d.* the pound. In medicine, the strong acid is used in the cure of ringworm, and the dilute acid is often prescribed as an internal remedy. In the arts the acid is largely used for various purposes, and, among others, for the manufacture of other chemicals; and, as the impure specimens of the acid sometimes contain large quantities of arsenic, that poison is often found in drugs and chemicals as an impurity.

For medico-legal purposes, we may have to examine, 1. The strong acid. 2. The dilute acid. 3. The acid in stains on cloth. 4. The acid in organic mixtures.

1. *Strong Sulphuric Acid.*

This is an oily liquid, heavier than water, without odour, not fuming, colourless when pure, but, as found in commerce, of a brown tint. It corrodes animal matters, and chars vegetable substances, and when added to water the mixture becomes hot. The charring property of the acid may be tested by a piece of paper or wood.

2. *Dilute Sulphuric Acid.*

The liquid is known to contain an acid by reddening litmus: it is probable that it contains either free sulphuric acid or free hydrochloric acid, if it chars vegetable matters;* and it is certain that it does so if, on adding a few drops of nitric acid, and then a solution of nitrate of baryta, a heavy white precipitate (the sulphate of baryta) falls down.

The sulphate of baryta collected, washed, and dried, being mixed with five times its weight of black flux, and heated on charcoal in the reducing flame of the blowpipe, is converted into a sulphide, which, on being placed in a test-tube, and moistened by dilute hydrochloric acid, gives off sulphuretted hydrogen, which may be readily detected by its odour, and by its effect on paper moistened with a solution of acetate of lead, and held over the mouth of the tube. By this threefold process an acid liquid is proved to contain sulphuric acid; but not necessarily as free acid. It may be as a constituent of a supersulphate, such as alum; or the precipitate of sulphate of baryta may have been obtained from a neutral sulphate, such as Epsom salts, and the acid reaction from some other free acid in excess. The presence of a saline ingredient, or of a neutral salt, will be proved by the result of evaporating the acid liquid; and the volatile acids, such as the acetic and hydrochloric acids, may be separated by distillation, and identified by appropriate tests.

3. *Stains on Cloth.*

The strong acid stains black cloth brown, and corrodes it. The stain continues moist for years, and has an unctuous feel. The dilute acid produces the same change of colour; but it is less corrosive, and the spots are dry.

* The charring property of sulphuric acid is so remarkable as to constitute a test. If a piece of filtering paper be dipped in a liquid formed by adding a single minim of the strong acid to 800 minims of distilled water, and then dried before a fire without scorching the dry portion of the paper, the part touched by the acid becomes black and brittle. Hydrochloric acid has the same property, though in a lower degree.

To detect the acid, the stained fragment of cloth must be digested in a small quantity of warm distilled water for a few hours. The liquid must then be filtered, and treated as dilute sulphuric acid. The acid may be detected after the lapse of several years. For medico-legal purposes, an unstained portion of the same cloth should be examined in the same way.

Clean linen and cotton fabrics corroded by the acid may be submitted to destructive distillation in a reduction-tube, over the mouth of which a slip of filtering paper, moistened with a solution of starch, and sprinkled with iodic acid, is held. The sulphurous acid gas combines with the oxygen of the iodic acid, and releases the iodine, which reveals its presence by the blue iodide of farina. This process is not applicable to woollen textures, which contain sulphates, and the results must, in any case, be compared with those of a parallel experiment with an unstained portion of the same material. The process is not applicable to the coats of the stomach, or to its contents.

4. *Organic Mixtures.*

Liquids containing organic matter, such as tea and coffee, beer and porter, if thick or turbid, must first be boiled with distilled water; if clear, they may be filtered at once. The coloured precipitate thrown down by nitric acid and nitrate of baryta is to be collected, and boiled in strong nitric acid, to destroy the organic matter, and converted into sulphide of barium, as above.

The contents of the stomach, or the matters rejected by vomiting, will have a strong acid reaction if no antidote has been given; but if the case has received medical treatment, or the patient has survived some time, they may be neutral, or even alkaline.

a. If they have an acid reaction, it is probable that they contain a free acid, which may be sulphuric acid, or one of the two acids usually found in the stomach, the acetic and hydrochloric. These acids may be separated by distilling the filtered liquid by the chloride of calcium bath (see hydrochloric acid), till it attains the consistence of a thin syrup. If, on testing the result of the distillation for hydrochloric and acetic acids, neither is present, the liquid in the retort must be diluted, filtered, and tested for sulphuric acid. If, however, the fluid in the receiver contain either acetic or hydrochloric acid, we dilute the liquid in the retort, and continue the distillation, adding fresh water as often as necessary, till all trace of these acids disappear. The fluid remaining in the retort is then to be tested for sulphuric acid.

If the fluid has an acid reaction, and also leaves a saline deposit on evaporation; and the result of distillation proves that the free acid is the sulphuric, we are dealing either with a supersulphate, such as alum, or with a sulphate, such as Epsom salts, in combination with free sulphuric acid. In the latter case, we may want to ascertain the quantity of the uncombined acid, which must be done by adding car-

bonate of baryta till effervescence ceases. The quantity of free acid may be calculated from the weight of the resulting sulphate of baryta.

b. If the organic matters have an alkaline reaction, or are neutral, they must be boiled in distilled water and filtered; the tests being applied to the filtered liquid.

If carbonate of lime has been given as an antidote, the resulting sulphate of lime must be dissolved by boiling with nitric acid.

When the quantity of acid discovered by any of these processes is very small, there is no proof that it has been swallowed; for the secretions of the stomach always contain a small quantity of neutral sulphates.

Nor does the discovery of a neutral sulphate, such as the sulphate of magnesia, prove the administration of free sulphuric acid, for the salt itself may have been given as an aperient.

The discovery of sulphate of lime, however, by proving the administration of sulphuric acid, and the subsequent use of chalk as an antidote, would be as conclusive as the finding of the free acid.

But where the characteristic appearances of poisoning with sulphuric acid are present, chemical analysis becomes superfluous, except in those rare cases in which the acid is taken in so dilute a form that its more marked post-mortem effects are absent.

Sulphuric acid has been detected in parts of the body to which it must have been conveyed by the blood. It has been found in the contents of the peritoneum, pleura, heart, and bladder, and even in the liquor amnii, and body of the fœtus. ('Med. Gaz.,' vol. i., p. 710.) The milk of nurses who were taking the acid has been found to produce disordered bowels and convulsions in children whom they were suckling; and in one case ('Med. Gaz.,' vol. i., p. 756) the matters voided from the bowels of the child were found to corrode the napkin.

Quantitative Analysis.—Use for this purpose the precipitated sulphate of baryta, previously boiled in pure nitric acid, and then carefully washed and dried. In 100 grains of the sulphate there are $41\frac{1}{2}$ grains of the strong acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described at p. 325, but severe in proportion to the strength and corrosive properties of the acid. Severe nervous symptoms are sometimes present, such as locked-jaw, rigid spasms of the extremities, epilepsy, and delirium.

Diagnosis.—The dark-brown stains on the skin, and the moist brown corroded stains on black cloth, are characteristic of this acid.

Post-mortem Appearances.—Those described at p. 327; but the degree of disorganization greater, and perforation more frequent (about two-thirds of the cases), than in poisoning by the other mineral acids. The colour of the epithelium and mucous membrane dark-brown or black, as if charred; while in cases of poisoning by nitric acid it is

more commonly yellow or green. When thickly coated with mucus, the lining membrane of the mouth and of the several portions of the alimentary canal acted on by the acid, has the appearance of being coated with white paint. Dr. Chowne has shown that this is the effect of sulphuric acid on the secretions of the alimentary canal after death. On the mucous membrane itself after death, the local effect of the acid, as shown by Orfila, is to render the membrane yellowish and brittle, to bleach the muscular and peritoneal coat, and to char the blood in the vessels.

Smallest fatal dose.—In the adult, one drachm. A less quantity in the infant. In one instance, half a teaspoonful of the dilute acid proved fatal to an infant five weeks old. ('Med. Gaz.,' vol. xxii., p. 389.) Two ounces have been swallowed by adults without fatal consequences.

Shortest fatal period.—Two hours. In fatal cases, life may be prolonged for several days, weeks, or even months.

Average Duration.—In cases which prove fatal within 24 hours, about 10 hours.

Mortality.—Almost all infants and young children. In adults, two-thirds of the cases.*

Treatment.—That already described at p. 328.

* The following are the general results of several cases reported in the English and Foreign Journals:—

Of 36 cases (of which the majority occurred in females)—26 were fatal (all the children and 18 adults), and 10 recovered (all adults).

Of 31 cases—20 were suicidal, 3 homicidal (all young children), and 8 accidental (2 of them children).

Among adults, the recoveries were to the deaths, both in accidental and suicidal poisoning, as 1 to 2.

Of the 26 fatal cases, 10 lasted a day or less; 6 more than a day and less than a week; 3 less than a fortnight; 1 from a fortnight to three weeks; 1 more than three weeks; and 5 extended from five to forty-five weeks.

The following were the precise periods of death—In 5 children, 1 in 3½ hours, 2 in 4½ hours, 1 in 12 hours, and 1 in 3 days. In 20 adults—1 in 3½ hours, 1 in about 4 hours, 1 in 8 hours, and 1 in 12 hours; 2 in 1 day, 1 in 1½ day, 2 in 2 days, 1 in 4 days, 1 in 5 days, 1 in 8 days, 1 in 11, 15, 22, and 33 days respectively, and 2 in 60 days: 1 in 26 weeks, and 1 in 45 weeks.

The average duration in all who survived a day or less was 10 hours—of all surviving a week or less 32 hours.

The recoveries are stated to have taken place in 6, 7, 10, 11, 14, 18, and 23 days respectively.

Perforation of the stomach took place in 8 cases out of 21 in which the post-mortem appearances are described.

The reader is referred to the following cases reported in English Journals, or extracted from foreign publications:—

Ed. Med. and Surg. Journal—Vol. x. p. 527. Vol. xxii. Vol. xxvi. Vol. xxxvi. p. 99. Vol. liii. p. 406 et seq. (an interesting case by Dr. Craigie with many valuable cases from foreign sources), and Vol. lvi. p. 537.—Lancet, 1834–5, i. p. 266. 1836—7, i. p. 195. 1837—8, ii. p. 782.—Medical Gazette, Vol. i. p. 127. Vol. vii. p. 27. Vol. xxii. p. 76. Vol. xxv. p. 944. Vol. xxix. p. 147. Vol. xxx. p. 352.—Medical and Physical Journal, Vol. i. p. 500.—Medical Repository, Vol. xiv. p. 160.—Guy's Hospital Reports, Vol. iv. p. 297.—See also Dr. Roupell's Illustrations of the effects of poisons.

Sulphuric acid has been introduced into the body in other ways than by the mouth. It has been injected into the vagina to procure abortion; and into the rectum by mistake for a clyster; and it is sometimes used to disfigure the face and injure the dress. The local treatment of parts thus injured will consist in the use of alkaline lotions to neutralize the acid, followed by that appropriate to burns.

2. NITRIC ACID. (*Aqua Fortis, Red Spirit of Nitre.*)

This acid is much less frequently used as a poison than sulphuric acid, but more frequently than hydrochloric acid. It was the cause of four deaths in 1837-38, two of which were from the unmixed acid; and of two deaths only in the five years 1852-56.

The poison may present itself for analysis, 1, as the strong acid; 2, as the dilute acid; 3, in stains on cloth; and, 4, in organic mixtures.

1. *Strong Nitric Acid.*

This acid, as met with in commerce, varies in colour from a deep orange to a light yellow; gives out orange-coloured acid fumes; produces dry yellow stains in black cloth, which it also corrodes, though in a less degree than sulphuric acid, and causes similar stains in other articles of dress, and in the skin and other tissues of the body. These stains become brighter when touched with an alkali. When poured on copper, tin, lead, or mercury, ruddy, colourless fumes of binoxide of nitrogen are given off, which immediately become ruddy on admixture with air, a brisk effervescence takes place, and a greenish liquid remains. With morphia and its salts, the acid strikes a rich orange colour.

2. *Dilute Nitric Acid.*

The liquid is proved to contain an acid by the effect on litmus paper. The addition of a few drops of pure nitric acid and nitrate of baryta, by the absence of precipitate, proves that sulphuric acid is not present. The absence of precipitate on adding a solution of nitrate of silver shows that it is not hydrochloric acid. If a mineral acid, therefore, it is nitric acid; and as most of the vegetable acids give a precipitate with nitrate of silver, there is a strong presumption in favour of the liquid containing nitric acid. This presumption is converted into certainty by the following tests:—*a.* When boiled with copper filings, provided the acid be not very dilute, the characteristic orange fumes are given off. *b.* If carbonate of potash is added to the liquid till effervescence ceases, and a piece of filtering paper is dipped into the liquid and dried, it burns like touch-paper. *c.* On slowly evaporating the liquid, it yields crystals of nitrate of potash.

The crystals of nitrate of potash obtained in this manner from the solution, yield further corroborative proofs of the nature of the acid, by the following reactions:—*a.* The crystals are lengthened, fluted prisms, permanent in the air. *b.* When ignited on charcoal, they burn

with deflagration. *c*. On the addition of strong sulphuric acid, a colourless vapour with the peculiar odour of nitric acid is given off. *d*. Place a fragment of the salt on a porcelain slab, add one or two drops of distilled water, and then a drop of strong sulphuric acid; in the resulting liquid place a fragment of morphia. The morphia will assume a rich orange colour, and gradually impart to the liquid a deep yellow tint. *e*. Substitute for the morphia a fragment of copper: the ruddy fumes of nitrous acid will be given off. *f*. Place on a porcelain slab a crystal of the salt, moisten it with distilled water, add a drop of concentrated sulphuric acid, apply the heat of a spirit lamp, and, as effervescence takes place, introduce into the liquid a crystal of the green sulphate of iron; a dark green ring, changing to brown, will form round the crystal. *g*. Place a crystal of nitre on a porcelain slab, moisten with distilled water, add a drop of strong sulphuric acid, and one or two drops of strong hydrochloric acid: the resulting liquid dissolves gold leaf.

3. *Stains on Cloth.*

Strong nitric acid injures the texture of black cloth, and produces a dry stain, which is at first yellow, or orange, but grows darker by the lapse of time. It is deepened in colour when touched by an alkali. The process of analysis is very simple. The fragment of cloth must be digested in a small quantity of warm distilled water. The presence of an acid will be indicated by test paper; and the nature of the acid will be inferred from the appearance of the stain. The acid is then to be neutralized with carbonate of potash, and the solution filtered. The dry filter will burn like touch-paper. Evaporate the liquid, collect the crystals, and apply the morphia test on a surface of white porcelain; and if possible apply the other tests in succession. As nitric acid is less permanent than sulphuric acid, it cannot be detected in stains on cloth after so long a period. But Dr. O'Shaughnessy obtained satisfactory evidence of its presence in a fragment of cloth from a coat which had been folded up "during the previous summer months."—('Lancet,' August 1830.)

It may be necessary to distinguish stains produced by nitric acid from those caused by iodine or by bile. The stains from nitric acid are indelible, and when touched with a weak solution of caustic potash become orange yellow. Those caused by iodine immediately disappear; the bile-stain undergoes no change. (Barruel.)

4. *Organic Mixtures.*

If the liquid is viscid, dilute with distilled water, boil, and filter. If it has an acid reaction, neutralize with carbonate of potash, crystallize, and apply the tests already described.

If antidotes, such as chalk or magnesia, have been given, the liquid, instead of having an acid reaction, may be neutral or feebly alkaline

In this case, also, the filtered liquid is to be neutralized with carbonate of potash; soluble nitrate of potash will be formed, and insoluble carbonate of lime or magnesia will be thrown down, which must be separated by fresh filtration. The filtered liquid is then to be evaporated, and the crystalline residue tested for nitrate of potash.

When the quantity of acid in the organic liquid is very small, it has been recommended to filter the liquid from the vessel containing it by means of a rough syphon formed of filtering paper. (Christison.)

Portions of mucous membrane acted upon by the acid may be treated in the same manner as fragments of cloth.

In the case of nitric as of sulphuric acid, the post-mortem appearances are so characteristic as to render chemical analysis unnecessary.

Quantitative analysis.—To the nitrate of potash add strong sulphuric acid; dissolve the sulphate, calcine it, wash with alcohol to remove free sulphuric acid, and evaporate to dryness. For one hundred grains of the dry sulphate allow about eighty-two grains of liquid nitric acid.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those already described (p. 325). A miliary rash, attended with intolerable itching, was present in one case on the sixth day.

Diagnosis.—The yellow stains on the skin, and the dry yellow corrosions on the dress, are characteristic of this acid; and the discovery of these stains on the person and dress has often led to detection in homicidal cases.

Post-mortem appearances.—Those already described (p. 327). The colour of the mucous membrane yellow or green in parts of the stomach and intestines containing bile. The degree of corrosion less, and perforation of rarer occurrence, than in poisoning with sulphuric acid.

Smallest fatal dose.—Two drachms. (Taylor.) In infants less. Recovery has taken place after half an ounce, or more.

The *shortest fatal period.*—In the adult one hour and three quarters: in the infant a few minutes.

Average duration.—In the majority of fatal cases death takes place within twenty-four hours; but life may be prolonged to several days, weeks, or months.

Treatment.—That prescribed for the mineral acids generally (p. 328).

Nitric acid has been introduced into the body in other ways than by the mouth. In one case it was poured into the ear, and caused in succession sloughing, abundant hæmorrhage, paralysis jactitans, extreme debility, and death in about thirteen weeks. ('Med. Gaz.' March, 1830.)

The orange fumes given off when nitric acid is poured upon copper or mercury (and which are commonly known as nitrous acid gas) are

produced in large quantity in some processes of the arts, such as water-gilding and brass-button making. They irritate the eyes and lungs, and give rise to a troublesome cough renewed by each repetition of the process; and at length becoming habitual. In more than one instance it has proved fatal in periods varying from twenty-seven hours to two days. The *symptoms* are a burning heat in the throat; tightness at the chest and pit of the stomach; extreme distension and acute pain of the abdomen; nausea and vomiting; purging of a yellow matter; scanty secretion of urine and dysuria; a cough at first dry, and then attended by scanty orange expectoration, with extreme dyspnœa, and feeling of impending suffocation; transient delirium; extreme debility; and inexpressible anxiety; and death after convulsions. The *post-mortem appearances* consist in signs of acute inflammation and its consequences in the air-passages and lungs, and in the alimentary canal, engorgement of the lungs and heart with black liquid blood, distension of the stomach and intestines with gas, and a yellow colour of the contents of the air-passages and alimentary canal. Manufacturers who produce these irritating fumes ought to be required to conduct them into the nearest chimney.

The binoxide or deutoxide of nitrogen which, when mixed with air, gives rise to these orange fumes, cannot be respired without producing them by combining with the atmospheric air in the lungs. Hence it cannot excite surprise that Sir H. Davy suffered very severely when he tried to inhale the binoxide.

3. MURIATIC ACID. (*Hydrochloric acid. Spirit of Salt.*)

Though muriatic acid is somewhat largely employed in the arts, it is not often used as a poison. No case of poisoning by it was reported in the years 1837-38; only two cases in the five years 1852-56, and less than half a dozen cases have occurred since that time. The poison may have to be examined, 1. As the strong acid. 2. As the diluted acid. 3. In stains on cloth. 4. In organic mixtures.

1. *Strong Muriatic Acid.*

The acid of commerce is of a yellow colour, fuming when highly concentrated, and yielding dense white fumes with the vapour of ammonia. It produces a green stain in black cloth, but does not corrode it; or the stain is first red and then green; and it reddens vegetable blues. It is distinguished from sulphuric acid by its colour, and from nitric acid by the absence of orange fumes when poured on metals. When boiled with black oxide of manganese, chlorine is given off, which is known by its colour, odour, and bleaching properties.

2. *Dilute Muriatic Acid.*

Having ascertained that the liquid contains an acid by the use of litmus paper, we first test it by nitric acid and nitrate of baryta;

if there is no precipitate it is probable that the acid is either nitric or muriatic. If on testing it with a solution of nitrate of silver we obtain a dense white precipitate, the probability is greatly strengthened; and if the precipitate is insoluble in nitric acid, and in caustic potash, but very soluble in ammonia, and, when dried and heated fuses into a horny mass, which may be cut with a knife, the acid is certainly muriatic acid.

As a chloride (such as common salt) with a free acid would have an acid reaction, and yield the same white precipitate with nitrate of silver, a portion of the liquid should be evaporated, when, if there is a crystalline residue, the acids should be distilled over and the crystalline residue examined.

3. *Stains on Cloth.*

Digest the stained cloth in warm distilled water, filter, test with nitrate of silver, and identify the precipitate as above. Examine, at the same time, an unstained portion of the same cloth.

4. *Organic Mixtures.*

Most organic liquids contain muriatic acid free or combined, and most organic matters yield a precipitate with nitrate of silver. In the contents of the stomach, the acid may either exist in the free state, in which case the liquid will have a strong acid reaction, or it may be combined with an antidote, in which case the liquid may be neutral.

If the liquid has a strong *acid* reaction, we submit it to distillation at a low temperature, by immersing the retort in a boiling solution of chloride of calcium (two parts of the salt to one of water), the distillation being repeated by adding distilled water to the dry residue. The liquid in the receiver may be treated as pure diluted acid.

If by this means we detect free muriatic acid in the contents of the stomach only in minute quantity, the proof of poisoning by this acid will be incomplete, for the gastric juice itself contains a minute proportion (one part in 1500) of free muriatic acid. But when the acid is found in considerable quantity in the stomach of a person in whom the symptoms during life and the post-mortem appearances were those due to the action of a mineral acid, the cause of death will be clearly proved.

If the organic liquid is neutral, it may either contain no muriatic acid, or the acid may be combined with an antidote—magnesia, lime, soda, or potash. In this case we evaporate to dryness and calcine, dissolve the residue, and test the solution with nitrate of silver.

If the residue consists of common salt, it may have resulted from the administration of carbonate of soda as an antidote, or the common salt may have formed a part of the food. Here, again, the result of the chemical analysis is worthless unless supported by the symptoms and post-mortem appearances, and the stains which we may discover on the clothes.

Quantitative Analysis.—Use for this purpose the dried precipitated chloride of silver, of which 100 grains are equivalent to 69 grains of liquid muriatic acid.

Symptoms.—Those already described (p. 325).

Post-mortem Appearances.—Those already described (p. 327). In a suicidal case, in which a large quantity of the strong acid was taken, and proved fatal in less than twenty-four hours, the epithelium of the throat and gullet was destroyed in patches, and the stomach contained a large quantity of black grumous matter, adhering to the surface so as to admit of being preserved. The preparation, with a drawing from the recent gullet and stomach, is in the Museum at King's College. As the appearances in this case, especially the shrivelled and worm-eaten aspect of the gullet, bear a very near resemblance to those present in cases of poisoning by sulphuric acid (see Roupell's Plates) and to one case of poisoning by oxalic acid which came under my notice, I append three woodcuts which, even in the absence of colours, convey a very clear idea of the actual appearances. Fig. 12 shows the corrugated and worm-eaten appearance of the gullet; fig. 13 a portion of the gullet from which a large patch of epithelium has been removed, and fig. 14 the appearance of the stomach with its black grumous contents and the vessels injected with black blood. The preparation was presented to the Museum by Mr. Bowman

Fig. 12.

Fig. 13.

Fig. 14.

The mucous membrane of the stomach and intestines sometimes has a yellow tint, or it is green from the action of the acid on the bile. No case of perforation has yet been reported; but in a case of poisoning by a large dose of the dilute acid reported by Puchelt of Heidelberg, the entire stomach is stated to have been destroyed, and rejected by vomiting.

Smallest fatal dose.—One ounce.

Shortest fatal period.—Five hours and a half.

Average period.—About twenty-four hours.

Treatment.—That of poisoning by the other mineral acids (p. 328).

Nitric acid mixed with sulphuric, under the name of *aqua reginæ*, and with muriatic acid, under the title of *aqua regia*, are used in the arts, the one to separate silver from plated articles and in the manufacture of collodion, the other to dissolve gold and platinum.

The mineral acids have also been taken in a state of mixture with other substances—nitric acid with laudanum, aloes, &c.; and muriatic acid, in combination with tincture of iron and corrosive sublimate, is in common use for browning gun-barrels, and has been taken as a poison in one case ('Medical Gazette,' November, 1839).

CHAPTER IV.

THE ALKALIS AND THEIR CARBONATES.

1. Potash and Carbonate of Potash.
2. Soda and Carbonate of Soda.
3. Ammonia and Carbonate of Ammonia.

THE alkalis and their carbonates share with the preceding sub-class of irritants, the mineral acids, the property of destroying the animal tissues by the violence of their action, at the same time that they give rise to no specific or peculiar remote effects. The corrosive property of these poisons belongs to them only when swallowed in substance, or in strong solution, as that of the mineral acids belongs to the concentrated acids or their less dilute mixtures.

The alkalis and their carbonates, in common with the alkaline earths, are distinguished from one class of the metals, commonly so called, by the negative effect of sulphide of ammonium, from another class by the negative effect both of hydro-sulphuric acid and sulphide of ammonium. They resemble the alkaline earths in having an alkaline reaction; but they differ from them by yielding no precipitate with carbonate of ammonia.

Though the alkalis and their carbonates are in very common use for household purposes, or as medicines, they are very rarely administered, or taken by accident, as poisons.

1. POTASH AND CARBONATE OF POTASH.

Caustic Potash, as used in the laboratory, is in the form of greyish masses, which present when broken an imperfect crystalline texture, are soapy to the touch, acrid to the taste, highly deliquescent, fusible by heat, rapidly absorbing carbonic acid from the air, and very soluble in water. When fused in small cylindrical moulds it is the *potassa fusa* of the shops.

In solution (the *liquor potassæ* of the shops and laboratory) it has a strong alkaline reaction; changes the colour of black cloth to brown; is not precipitated by carbonic or sulphuric acid, but yields with a solution of bichloride of platinum a yellow precipitate.

The *carbonate of potash*, *bicarbonate of potash*, or *salt of tartar*, is sold by oilmen in two forms. 1. As a mottled deliquescent mass—yellow, grey, brown, and black—with a soapy feel, a urinous taste, and a strong alkaline reaction. In this form it is known as *Potash* or

Potashes, and is used chiefly for cleaning oil lamps. 2. In small white grains, or as a white semi-crystalline mass, having similar detergent properties, and used for washing and other cleansing purposes. In this form it is known as *Pearlash.*

We may have to examine and identify these salts. 1. In substance. 2. In solution. 3. In organic mixtures.

1. *In Substance.*

Potash (or potashes) is readily recognized by the physical properties just described. The more pure form of carbonate of potash requires to be distinguished from carbonate of soda, and from other white powders. It has an alkaline reaction, effervesces and gives out carbonic acid when treated by acids, and imparts a violet tint to the deoxidizing flame of the blowpipe. It is very soluble, and has in a state of solution the properties now to be described.

2. *In Solution.*

A solution of carbonate of potash when evaporated on platinum foil leaves a white deposit not dissipated by heat, and is thus distinguished from the salts of ammonia: it has an alkaline reaction; it yields a yellow precipitate with a solution of bichloride of platinum, in which respect it resembles the salts of ammonia, but differs from those of soda; it gives a colourless precipitate of bitartrate of potash with a solution of tartaric acid, which precipitate is promoted by agitation and by friction with a glass rod.

3. *In Organic Mixtures.*

If an organic liquid has a strong alkaline reaction, there is a presumption in favour of one of the substances contained in this chapter. By diluting and filtering a small portion of the liquid, and applying trial tests, it will be easy to ascertain which of the three alkalis is present. The process for the carbonate of potash consists in evaporating the organic matter to dryness, incinerating the residue, treating the ash with distilled water, and applying to the solution the tests just enumerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—When a strong solution of the poison is taken, an acrid burning taste is perceived in the act of swallowing, followed immediately by a burning sensation in the throat and gullet. This is soon followed by acute pain in the pit of the stomach, with great tenderness on pressure; frequent and violent vomiting of a tenacious bloody mucus, of a brown grumous matter, or of flakes of epithelium. Violent colic pains, with tension and tenderness of the abdomen, soon supervene, and there is purging of stringy mucus mixed with blood.

There is much difficulty in swallowing, and sometimes hoarseness of the voice, and cough. In fatal cases, death either takes place with symptoms of collapse, or after prolonged sufferings from increasing difficulty in swallowing, constant vomiting of blood, bloody stools, and tenesmus. In chronic cases the patient dies from starvation, through the long-continued stricture of the œsophagus.

Post-mortem Appearances.—The lining membrane of the throat and gullet is softened and corroded; the œsophagus, stomach, and intestines are inflamed, with abrasion and ulceration of the lining membrane, and dark spots or patches caused by the extravasation of blood. Sometimes the inflammation extends to the larynx. In chronic cases, large portions of epithelium and mucous membrane are found removed, and the gullet and stomach are contracted. Perforation has not taken place in any of the recorded cases.

Smallest fatal quantity.—Half an ounce.

Shortest fatal period.—Three hours.

Average fatal period.—In the majority of fatal cases death takes place within twenty-four hours. In chronic cases, the fatal event may be delayed for days, weeks, months, or even years.

Treatment.—As an antidote, vinegar largely diluted with water or lemon-juice and water. Acidulated demulcent drinks, and the juice of oranges and ripe fruits may then be freely administered, and almond or olive oil. Inflammatory symptoms must be combated with antiphlogistics, pain by preparations of opium, and collapse, if present, by the usual stimulants. The stomach-pump should not be used.

2. SODA AND CARBONATE OF SODA.

Caustic soda has no medico-legal interest. *Carbonate of soda* is sold by oilmen for cleansing purposes, in two forms, as *soda* and *best soda*—the soda in a dirty crystalline mass, the best soda in masses of a purer white. In common with potash, carbonate of soda may have to be identified in substance, in solution, and in organic mixtures.

1. *In Substance.*

Carbonate of soda has an alkaline reaction; it effervesces and gives out carbonic acid when treated with an acid; it readily crystallizes, and is efflorescent, and it imparts a yellow colour to the flame of the blowpipe.

2. *In Solution.*

A solution of carbonate of soda differs from a solution of carbonate of potash by yielding no precipitate with the bichloride of platinum, or with tartaric acid; while it gives with antimoniate of potash a white crystalline precipitate. Further distinctions might, if necessary, be founded on the form and character of the salts of the two alkalis; but this is unnecessary. It will suffice to state that when converted into

nitrates by adding dilute nitric acid, soda crystallizes as rhombic plates, and potash as prisms.

3. *In Organic Mixtures.*

The process for organic liquids containing carbonate of soda is the same as for those containing carbonate of potash.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Those of poisoning by carbonate of potash, but of less severity.

Post-mortem Appearances.—Those of poisoning by carbonate of potash, though less marked.

Treatment.—That of poisoning by carbonate of potash.

3. AMMONIA AND CARBONATE OF AMMONIA.

Ammonia in the form of gas, or dissolved in water, as the *liquor ammoniæ*, or in combination with carbonic acid gas as the *sesquicarbonate of ammonia*, is largely used in medicine and the arts, and is occasionally taken as a poison, generally by accident; but in rare instances it is taken or given with intent to destroy life. The incautious use of the vapour of ammonia with a view to rouse patients from syncope, or asphyxia, or as an antidote to prussic acid, has also caused death by suffocation or inflammation of the air-passages.

The vapour of ammonia is readily recognized by its pungent odour, and it is distinguished from the fixed alkalis by the change produced in vegetable colours being dissipated by heat. The *sesquicarbonate* (vulgarly known as hartshorn, volatile salt, or smelling salts) is recognized by its pungent odour. and distinguished from the carbonates of potash and soda by being completely dissipated when heated on platinum foil. It is distinguished from liquid ammonia by effervescing with an acid, and yielding a white precipitate with the salts of lime.

Ammonia is set free from its salts when they are heated with liquor potassæ in a test tube, the vapour of ammonia being identified by the odour, by its alkaline reaction on turmeric or reddened litmus paper, and by the dense fumes formed when brought into contact with hydrochloric acid. Ammonia in *organic mixtures* must first be separated by distillation and then identified by its appropriate tests.

Symptoms.—These, as far as they are due to actual contact, are the same as those produced by potash and soda, and their carbonates; but from its extreme volatility it gains access to the air-passages, and has thus proved fatal in so short a time as *four minutes.*

Post-mortem Appearances.—Signs of violent inflammation in the alimentary canal with separation of the epithelium of the mouth, and inflammatory appearances in the air-passages.

Trratment.—Vinegar and water as an antidote, and the after-treatment proper to the class of irritants.

CHAPTER V.

THE VEGETABLE ACIDS.

1. Oxalic Acid (and the Binoxalate of Potash).
2. Tartaric Acid (and Bitartrate of Potash).

1. OXALIC ACID (*Acid of Sugar*).

THIS substance is largely used in the arts, under the common name of acid of sugar. It is in use among bookbinders, shoemakers, and workers in leather, among straw-bonnet makers and workers in straw; and among workers in brass. It is also commonly employed to take ink-stains out of linen. It is sold both by druggists and by persons who supply the trades using it. Its cheapness (2*d.* per ounce), common employment, and known activity, commend it to the suicide; its resemblance to Epsom salts leads to accidents; while its strong acid taste unfits it for the purpose of the murderer, unless mixed with some strongly-flavoured liquor, such as gin, brandy, or rum, or strong tea or coffee.

Oxalic acid, for the reasons stated, is in common use as a poison, taking the sixth place among the ascertained poisons. In the five years, 1852-56, it was credited with 13 deaths per annum, or about 1 in 21 of the ascertained poisons. Of these 13 deaths, 4 occurred in men and 9 in women, and 10 of the 13 were suicidal cases. Of the 19 cases traced to oxalic acid in the two years, 1837-8, 13 were suicidal and 1 accidental; while of 15 cases which I have collected from different sources, 8 were suicidal, 5 accidental, and 2 unascertained. Of the 15 cases 12 occurred in women and only 3 in men.

Tests.—Oxalic acid may have to be examined in substance, in solution, and in organic mixtures.

1. *In Substance.*

The crystals are transparent, colourless or nearly so, permanent in the air (unless containing nitric acid), very sour to the taste, soluble in about their own weight of hot water, and in from eight to twelve or fourteen times their weight of cold water. They are also soluble in alcohol.

The crystals are four-sided prisms, with dihedral or tetrahedral summits; and they bear such a resemblance to the crystals of sulphate of magnesia and sulphate of zinc, as to be occasionally confounded with them. The distinction, however, is easy. Oxalic acid has an intensely

sour taste; the other salts are bitter: the solution of oxalic acid has a strong acid reaction; that of the sulphate of magnesia is neutral, and of the sulphate of zinc only slightly acid: oxalic acid is entirely dissidated by heat, or, if impure, leaves only a scanty saline residue; the sulphates of magnesia and zinc are fixed: liquor potassæ added to a solution of oxalic acid produces no change; but it precipitates the white oxides of the sulphates of magnesia and zinc; oxalic acid effervesces with solutions of the alkaline carbonates, but yields no precipitate, while the sulphates of zinc and magnesia give a white precipitate, without effervescence. Oxalic acid discharges the colour of ink; the other crystals produce no change in it. Oxalic acid is sufficiently distinguished from the citric and tartaric acids by the defined shape of its crystals.

2. *In Solution.*

The liquid is known to contain an acid by its action on litmus, and a vegetable acid or acid salt if it yields crystals on evaporation. Long slender prismatic crystals, dissipated by heat, afford a strong probability of the presence of oxalic acid. On the supposition that we are ignorant of the nature of the acid, we acidulate with a few drops of nitric acid and then add a solution of nitrate of baryta. The absence of precipitate shows that it is not sulphuric acid. We then add to another portion of the liquid a few drops of a solution of nitrate of silver; a white precipitate is thrown down, which will be identified as oxalate of silver by the tests presently to be described.

If we have reason to believe that the acid liquor contains oxalic acid, we may obtain more complete evidence by evaporating and obtaining crystals, or by the addition of ammonia, which, if the solution contain a large proportion of the acid, will produce a characteristic radiated crystallization of oxalate of ammonia. The characteristic tests by which the oxalic acid may be fully identified are the following:

1. *Nitrate of Silver.*—It throws down an abundant white precipitate of oxalate of silver, soluble in nitric acid and ammonia; and which, when dried and heated on platinum foil, detonates, and is dispersed as a white vapour, leaving a residue of metallic silver.

2. *Sulphate of Lime.*—The salts of lime give with oxalic acid a white precipitate, the oxalate of lime, soluble in nitric and hydrochloric acids, but insoluble in the vegetable acids. The solution of the sulphate of lime should be added in large quantity.

A solution of sulphate of copper is often mentioned as a test for oxalic acid. It throws down a greenish-white precipitate of oxalate of copper. The soluble salts of lead also give a white precipitate—a fact of which we avail ourselves in the process for organic liquids.

3. *In Organic Liquids.*

As oxalic acid is not altered by contact with the animal textures or with food, and it is not often that an antidote can be given, the process for the free acid is comparatively simple.

The acid liquid if dilute may be filtered at once, but if not, we add distilled water, allow the liquid to stand for a time, filter it, and concentrate by evaporation. To the resulting liquid we add acetate of lead till a precipitate ceases to be formed. This precipitate, the oxalate of lead, is then diffused through distilled water, and sulphuretted hydrogen gas transmitted for two hours through the mixture. Black sulphuret of lead is thrown down, and oxalic acid is set free. The sulphuret having been separated by filtration, the oxalic acid remains in solution, and may be identified by the tests just described.

If carbonate of lime or of magnesia had been employed as an antidote, we shall have to adopt a modified process by which the acid may be detached from the base. The fragments of solid matter must first be rubbed down, and the mixture must then be brought to the consistence of a thin syrup by the addition, if necessary, of distilled water. To this about a twentieth part of its bulk of carbonate of potash must be added, and it must then be boiled for two hours. The resulting liquid will contain soluble oxalate of potash, and insoluble carbonate of lime or of magnesia. The insoluble matters being now separated by filtration, the liquid which passes the filter will consist of oxalate of potash in solution. The alkali is now to be neutralized with pure nitric acid, and the solution of acetate of lead is to be added as long as any precipitate falls. Collect, as before, the oxalate of lead, suspend it in distilled water, separate the oxalic acid by sulphuretted hydrogen gas, and identify the oxalic acid by the tests already described.

If the antidotes which have been administered have only partially neutralized the oxalic acid, and the separated liquid has an acid reaction, the process first described must be adopted for the liquid portion, and the second process for the solid matters.

As oxalate of lime exists in large proportion, but in small absolute quantity in rhubarb, it is always possible to attribute its detection, when in small quantity, to rhubarb taken medicinally. The history of the case, with the previous symptoms and post-mortem appearances, will at once destroy this objection.

A strong solution of oxalic acid stains black cloth of a deep-brown colour without corroding it, and reddens the vegetable blues. In consequence of its removing the colour of ink, it has been used to discharge writing.

Quantitative Analysis.—Use for this purpose the oxalate of lead. Every hundred grains correspond to forty-two of the crystallized acid.

Experiments on Animals.—Large doses (such as ℥ss.) in strong solution cause symptoms of irritant poisoning, and death from collapse in from two to twenty minutes. After death, black extravasated blood is found in the stomach, and there are marks of acute inflammation, with hardening or softening of the lining membrane. The diluted acid in large doses kills by paralyzing the heart; in lesser doses by tetanic spasm of the muscles of respiration, and in still smaller ones by coma.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms in man vary with the dose and the degree of concentration of the poison. When the dose is large, and the solution concentrated, the symptoms follow immediately on the swallowing of the poison. An intensely sour taste is speedily followed by a burning sensation in the pit of the stomach, increased by pressure, and pain and constriction of the throat. The pain is soon succeeded by vomiting, sometimes of blood, but generally of a greenish-brown or black grumous matter. If the patient survive several hours, there is purging of a similar matter, sometimes tinged with blood. The remaining symptoms are those of collapse,—extreme debility, pale and anxious countenance, cold and clammy skin, small and frequent pulse, and hurried respiration. There are also soreness of the mouth, inflammation and swelling of the tongue, constriction of the throat, painful deglutition, intense thirst, restlessness, difficulty of breathing, and harassing cough. Cramps and numbness of the legs and arms, acute pain in the head and back, delirium and convulsions, are among the nervous symptoms present in certain cases.

These symptoms are subject to many anomalies and exceptions. Even pain and vomiting have been altogether absent, or vomiting did not occur till emetics were administered. An eruption has in one case appeared on the skin. From the speedy death of leeches applied to the epigastrium in a case of poisoning by oxalic acid, it is inferred that the blood is poisoned.

Post-mortem Appearances.—The external appearance of the body is natural, and the countenance pale and composed. The lining membrane of the mouth and fauces is generally white, shrivelled, and easily detached; and a similar appearance extends into the gullet, which is contracted into folds both longitudinally and transversely, while the epithelium is detached in small irregular patches, leaving a brown surface beneath. The tube sometimes closely resembles a piece of worm-eaten wood. (See figures 12 and 13, p. 338.) The stomach contains a dark-brown, or greenish-brown, grumous matter, in appearance nearly resembling *meconium*, which also lines the œsophagus, and extends into the duodenum. The mucous membrane is sometimes quite pale, and free from rugæ; at others, the membrane is highly inflamed, and the rugæ strongly marked. It is easily stripped off, and in some instances has been extensively detached. Its vessels are minutely injected with black blood. (See fig. 14, p. 338.) Perforation is rare. In cases of some continuance, the small intestines present the same appearances as the stomach. The peritoneum has been found inflamed, and in one case the right pleura. The lungs are sometimes greatly congested, and in one instance there were some traces of inflammation in the brain.

In rare instances, the most characteristic post-mortem appearances, like the symptoms during life, are absent.

As a general rule it may be stated that both the symptoms and post-mortem appearances, in poisoning by oxalic acid, are highly characteristic. Christison justly observes, "If a person, immediately after swallowing a solution of a crystalline salt, which tasted purely and strongly acid, is attacked with burning in the throat, then with burning in the stomach, vomiting, particularly of bloody matter, imperceptible pulse, and excessive languor, and dies in half an hour, or, still more, in twenty, fifteen, or ten minutes, I do not know any fallacy which can interfere with the conclusion, that oxalic acid was the cause of death. No parallel disease begins so abruptly, and terminates so soon; and no other crystalline poison has the same effects."* It may be added, that the post-mortem appearances, though not equally characteristic, afford a strong probability. The wrinkled and corroded gullet, the pale, shrivelled, and partially-detached mucous membrane of the stomach, the dark veins ramifying on its surface, and the dark-brown grumous matter which fills its cavity, point strongly to the action of a powerful corrosive poison, while the absence of the coloured spots on the skin would preclude the supposition of the effect being due to either of the mineral acids.

First appearance of the symptoms.—When the quantity of the poison is considerable, and the solution concentrated, the symptoms begin immediately. If the quantity is small, and the solution weak, they may be delayed for some hours.

Smallest fatal dose.—Less than *half an ounce* has proved fatal; but a smaller quantity has produced severe symptoms, and, on the other hand, recovery has taken place after the administration of two or three times as much. When active treatment is immediately adopted the patient often recovers.

Shortest fatal period.—Death has taken place in *ten minutes*, the dose being one ounce. In one case, the subject of an inquest held by Mr. Wakley, it must have been nearly instantaneous. Death has taken place in one case at the end of twenty-three days, the dose having been half an ounce.

Mortality.—The majority of cases prove fatal. A small number are recovered by prompt treatment.

Treatment.—The proper antidote is chalk, suspended in water. Magnesia or its carbonate may also be used: in the absence of these the plaster of the apartment. Lime water and oil have been used

* Of 11 cases of poisoning by oxalic acid reported in the Journals, 5 were accidental, and 6 suicidal. Of the accidental cases, 3 were by mistake for Epsom salts. Of 13 cases, 6 recovered and 7 died. 3 occurred in males and 10 in females. The duration of the fatal cases was as follows—2 of a quarter of an hour, 1 of twenty minutes, 1 of less than half an hour, and 1 of eight days. The average duration of the first 4 cases was about twenty minutes.

The reader is referred to the following cases:—Med. Gazette, i. 757: v. 704: xxvii. 870: xxxi. 491. London Medical Repository, vi. 474: xi. 20; xii. 18. Lancet, Dec. 15, 1827: vol. ix.: x. 512: xxxii. 748, xxxiii. 29. Guy's Hospital Reports, vii. 353. Edin. Med. and Surg. Journal, xxiv. 67.

with advantage; but the alkalis are inadmissible. Warm water may be given freely, after the use of the antidotes. If vomiting is not present, emetics of sulphate of zinc may be employed. The stomach-pump should either not be used, or it should be introduced with the greatest caution.

BINOXALATE OF POTASH (*Salt of Sorrel—Essential Salt of Lemons*).

This salt is a constituent of wood-sorrel and of other plants. Like oxalic acid itself, it is used for bleaching straw and removing ink-stains, for which purpose it, or a quadroxalate of potash, is sold under the name of "essential salt of lemons," for three halfpence the half ounce. As a poison it is scarcely inferior in activity to oxalic acid. It has been taken by mistake for the bitartrate of potash, or cream of tartar.

Tests.—The salt is found in the form of colourless rhombic prisms. It has a sour taste, and strong acid reaction. It is much less soluble in water than oxalic acid, requiring 40 parts of water for its solution. It resembles oxalic acid in yielding a white precipitate with nitrate of silver and sulphate of lime, and it has the same reactions with sulphate of copper and the salts of lead.

When the crystals are heated, they leave a white ash of carbonate of potash, which effervesces with nitric acid, forming nitrate of potash.

Symptoms.—Those of poisoning by oxalic acid. In a case of recovery from poisoning by a quarter of a tea-spoonful of this substance, lately reported by Dr. F. C. Webb, there was burning in the throat, a red tongue, intense thirst, no abdominal pain, vomiting after the lapse of two hours, severe pain in the loins, dysuria, great weakness of the legs, pain in the head, and cramps in the hands and legs.

Post-mortem Appearances.—The same as in poisoning by oxalic acid.

Treatment.—That of poisoning by oxalic acid.

Smallest fatal dose.—Half an ounce.

Shortest fatal period.—Eight minutes, in a lady recently delivered.

Mortality.—Like oxalic acid, it has proved fatal in the greater number of cases.

2. *Tartaric Acid.*

This acid has been taken as a poison once in England and once in France.

Tests.—This acid crystallizes in oblique rhombic prisms. It is colourless, and has a pleasant taste; is soluble in five or six times its weight of water, and less soluble in alcohol. When heated, it first fuses, and then burns with a light red flame, giving out a peculiar

odour, and leaving an abundant deposit of carbon. Carbon is also deposited when it is heated with strong sulphuric acid.

The solution deposits feathery crystals; it yields no distinct precipitate with nitrate of silver; and it gives a white granular precipitate with the salts of potash. This precipitate (the bitartrate) is promoted in dilute solutions by friction of the sides of the vessel with a glass rod.

Experiments on Animals.—These prove that tartaric acid is much less active than oxalic acid. In full doses it destroys life in less than an hour, with marks of great weakness, and palsy of the limbs.

Symptoms.—In the large quantity of one ounce, dissolved in half a pint of warm water, the poison has proved fatal to a young male adult in nine days, with the ordinary symptoms of irritant poisoning. There are no specific symptoms.

Post-mortem Appearances.—In the case just referred to, inflammation of the greater part of the alimentary canal.

Treatment.—By the same antidotes as oxalic acid, with the after-treatment proper to the class of irritants. The soluble salts of potash are not contra-indicated, as in poisoning by oxalic acid.

Bitartrate of Potash (*Cream of Tartar, Argol*).—In large doses, such as two ounces and upwards, this salt is a decided poison. It has destroyed the life of an adult male in forty-eight hours, with the symptoms and post-mortem appearances of irritant poisoning. This substance is generally found as a white powder, sparingly soluble in water, and the solution has a feeble acid reaction. The powder when heated is converted into carbon and carbonate of potash, which latter effervesces with acids. The base may be identified by bichloride of platinum. It may be obtained as a sediment from organic liquids. The *treatment* is by copious demulcents, and by other remedies appropriate to the condition of the system. A dilute solution of the bicarbonate of potash may be given with advantage; as it reduces the bitartrate to the condition of a harmless purgative salt—the neutral tartrate.

3. *Citric Acid.*

Experiments on animals show that this acid is a more active poison than the tartaric acid. If a case of poisoning should occur by it, the treatment would be that of poisoning by oxalic or tartaric acid.

CHAPTER VI.

SALTS OF THE ALKALIS AND EARTHS.

The carbonates of potash, soda, and ammonia have been already examined (see p. 340), the bitartrate of potash at p. 350, and the binoxalate of potash at p. 349; iodide of potassium will be treated of in Chapter X. The poisons, therefore, which remain to be examined in this chapter are:—

1. The Nitrate of Potash.
2. The Sulphate of Potash.
3. The Sulphate of Alumina and Potash.
4. The Sulphuret of Potassium.
5. The Chloride of Sodium.
6. The Chlorides of Lime, Soda, aud Potash.
7. The Salts of Baryta.

The nitrate and sulphate of potash, the sulphate of alumina and potash, and the bitartrate of potash (p. 350), as also the chloride of sodium, resemble each other in being weak poisons, that is to say, in only acting as such in large doses. They are not generally considered poisons, and more than one of them has consequently been taken to discharge worms or to procure abortion. The sulphuret of potassium is a more active and fatal poison, and combines the irritant action of the base with the narcotic property of the sulphuretted hydrogen gas.

NITRATE OF POTASH (*Nitre, Saltpetre, Salprunelle*).

Poisoning with this substance is generally accidental, it being taken by mistake for sulphate of soda or sulphate of magnesia.

Properties.—It is sold in two forms—in colourless or nearly colourless crystals, or in crystalline masses; and in white spherical or circular cakes (salprunelle). It has a salt cool taste, and the familiar property of causing matters with which it is mixed to burn with deflagration.

Tests.—See nitric acid (p. 333).

Symptoms.—It is only when given in large doses that nitre is injurious. I have repeatedly given it medicinally in doses of a scruple, and it has been administered in doses of two and three scruples, and even to the extent of half an ounce in a dose, without injurious effects. It has also been taken in doses of one or two ounces without producing any more severe effect than a strong emetic or purgative. But several cases are on record in which doses of an ounce and upwards

have produced very severe effects. In such doses the symptoms are those of acute irritant poisoning, with profuse discharges of blood by vomiting and purging, and bloody urine. There is extreme prostration of strength, accompanied or followed in some instances by nervous symptoms, such as convulsions, slight trismus, tetanus, and stupor, loss of speech, sensation, and voluntary motion, and illusions of the senses. In one case there was chorea of two months' duration.

Fatal Dose.—One ounce of the salt has proved fatal, and death has taken place in *three* hours. In such cases the fatal event is due to collapse.

Post-mortem Appearances.—Marks of violent inflammation in the stomach and small intestines, with black patches in the stomach, resembling gangrene. In one case there was a small aperture in the stomach.

Treatment.—As there is no antidote, the treatment is that of the irritants as a class (p. 318). Vomiting, if absent, should be promoted by emetics, followed by the abundant use of diluents, or the stomach-pump may be used. Antiphlogistic remedies may be required, to combat high inflammatory action, sedatives if nervous symptoms are present, and stimulants in case of collapse.

SULPHATE OF POTASH (*Sal de duobus, Sal Polychrest*).

This salt has more than once proved fatal when administered in large doses. In a French case, ten drachms given, in divided doses, to a lady within a week of her confinement proved fatal in two hours, with the symptoms and post-mortem appearances of irritant poisoning. In a suicidal case, in which Dr. Letheby gave evidence, ℥iss of the poison gave rise to marked appearances of irritation in the stomach and small intestines.

Tests.—The salt is readily identified by the nitrate of baryta, as a test for the acid, and the bichloride of platinum as a test for the base.

Treatment.—That of irritant poisoning (p. 318).

SULPHATE OF ALUMINA AND POTASH (*Alum*).

This substance has been very rarely taken as a poison.

Properties.—It is found in commerce as a colourless crystalline mass, or in the calcined state as a white mass or powder. It is also to be met with as iron-alum. It has a sour taste, and yields an acid solution, which is readily distinguished from dilute free acids by evaporation. If a drop of a solution of alum is placed on a slip of glass, it commonly leaves on evaporation a beautiful compound crystal, consisting of straight parallel columns crossed at right angles by short lines, and surrounded by rectangular crystalline forms. These compound crystals are blended with right octahedra, more or less perfectly formed. From saturated or strong solutions of alum the

crystals are deposited either as right octahedra or as cubes, and large masses of crystals, consisting of piles of octahedra, either colourless or coloured, are familiar objects in the shops.

Tests.—The sulphuric acid may be detected by the solution of nitrate of baryta; the alumina is thrown down by liq. potassæ, as a white precipitate, soluble in an excess of the precipitant; and the potash may be detected by the chloride of platinum.

Symptoms.—Those of simple irritant poisoning (p. 317).

Treatment.—That of simple irritant poisoning (p. 318). After emptying the stomach by the stomach-pump or by emetics, lime-water may be given with advantage.

SULPHURET OF POTASSIUM (*Liver of Sulphur*).

The alkaline sulphurets are active poisons, containing an irritant base with a narcotic gaseous acid.

Properties.—It is found in the shops in dirty green masses, or in powder of the same colour. It yields a yellow solution, and has a strong odour of sulphuretted hydrogen.

Tests.—On the addition of an acid the gas is disengaged, and produces its characteristic effect on paper moistened with acetate of lead.

Symptoms.—Those of acute irritant poisoning, with the addition of convulsions, or of stupor. The breath, and the matters discharged from the stomach and bowels, have the odour of sulphuretted hydrogen. Death may occur in so short a time as a quarter of an hour.

Post-mortem Appearances.—Redness of the stomach and duodenum, and deposit of sulphur on the mucous membrane. The surface of the body very livid. The lungs gorged with dark blood.

Treatment.—Dilute solutions of chloride of soda or lime (bleaching liquids) should be immediately administered. The remainder of the treatment is that of irritant poisoning.

CHLORIDE OF SODIUM (*Common Salt*).

Properties and Tests.—The salt is soluble in water, and the solution on evaporation yields cubic crystals. The acid is detected by the solution of nitrate of silver, which throws down the white chloride. The base may be detected by the negative reaction with the bichloride of platinum.

Symptoms.—Those of irritant poisoning (p. 317).

Treatment.—That of irritant poisoning (p. 318).

CHLORIDES OF LIME, SODA, AND POTASH (*Bleaching Powders and Liquids*).

The chloride of lime, hypochlorite of lime, or common bleaching powder; the chloride of soda, hypochlorite of soda (in solution),

Labaraque's or Fincham's liquid; and the chloride of potash, hypochlorite of potash, or Eau de Javelle, are all poisonous.

Properties.—All these substances and solutions yield chlorine spontaneously or on the addition of an acid, and they have a strong odour of the gas. The gas is readily identified both by its peculiar odour and by its bleaching properties.

The symptoms, post-mortem appearances, and treatment in poisoning by these substances would be those proper to the class of irritants.

SALTS OF BARYTA.

The salts of baryta have been occasionally taken as poisons. The muriate and the carbonate have both proved fatal. The nitrate and acetate are also possessed of poisonous properties.

Properties.—The chloride of barium is found in commerce irregularly crystallized in tables. It is permanent in the air and soluble in water, and has an acrid taste. The carbonate is commonly found in the shops as a fine white powder, insoluble in water, but soluble with effervescence in dilute acids. Though insoluble in water, it is readily decomposed by the free acids of the stomach.

Tests.—Baryta is precipitated from its solutions as a white carbonate by carbonate of potash, and as an insoluble white sulphate by sulphuric acid or the alkaline sulphates. Oxalic acid does not precipitate baryta from dilute solutions. The acids in combination with the base are easily distinguished: the carbonic acid by effervescing on the addition of dilute mineral or vegetable acids; the muriatic acid by nitrate of silver; the nitric acid by precipitating the base with sulphate of potash, when nitrate of potash will remain in solution; and acetic acid by the odour of the vapour disengaged on adding dilute sulphuric acid.

Symptoms.—Those of irritant poisoning (p. 317), with the addition of nervous symptoms in a marked form, such as violent cramps and convulsions, headache, excessive debility, dimness of sight and double vision, noises in the ears, and violent palpitation of the heart. The occurrence of such symptoms would justify the removal of this poison to the class of specific irritants.

Post-mortem Appearances.—Those of irritant poisoning (p. 317). In one case, in which death took place in two hours, the stomach was found perforated.

Treatment.—The free administration of the sulphate of soda or of magnesia as an antidote, with the use of emetics and the stomach-pump. The after-treatment is that common to the whole class of irritants. (See p. 318.)

CHAPTER VII.

VEGETABLE IRRITANTS.

1. Purgative medicines.
2. Juniperus sabina.
3. Taxus baccata.
4. Daphne mezereum.
5. Arum maculatum.
6. Colchicum autumnale.
7. Veratrum album (veratria).
8. Helleborus niger.
9. Diseased and decayed vegetable matters.

THIS group consists, 1. Of substances belonging to the class of purgative medicines — Aloes, colocynth, gamboge, jalap, scammony, castor-oil seeds, and croton seeds and oil. 2. Of other vegetable irritants not commonly used as aperients—Savin, yew, mezereon, arum maculatum, colchicum, and hellebore. 3. Diseased and decayed vegetable matters.

1. Of the first group, which comprises the more active purgatives, it will suffice to state that when given in large doses, or to a person suffering from great debility, they may act as poisons. All those enumerated above, given alone or in combination, have proved fatal. They owe their poisonous property chiefly to the oily or resinous matters which they contain. Two of the poisons in the second group (colchicum and stavesacre) owe their irritant properties to alkaloids (colchicina and delphinia); and the poisonous effects of another vegetable irritant (hellebore) are said to be due to a neutral crystallizable principle (helleborine).

The vegetable irritants are often identified in the contents of the alimentary canal by fragments of their leaves, fruits, or seeds.

The *symptoms* produced by this class of poisons are those of irritation of the alimentary canal—vomiting and purging, with pain in the abdomen, tenesmus, and strangury. The patient falls into a state of collapse, attended occasionally with drowsiness and slight nervous symptoms.

The *post-mortem appearances* are those of inflammation of the alimentary canal in various degrees and stages—redness, ulceration, softening, and effusion of dark blood into the submucous tissue.

The *treatment* proper to the whole class of vegetable acrids consists in the administration of emetics when vomiting is absent, followed by the free use of diluents; in local or general blood-letting when inflammatory symptoms run high, and in the use of stimulants or narcotics if collapse or nervous symptoms are present.

2. Savin (Juniperus sabina).—This is a small indigenous bushy shrub, yielding a round purple fruit about the size of a currant. It has a peculiar strong odour, and an acrid taste; and owes its irritant properties chiefly to an essential oil readily obtained from the fresh tops of the plant by distillation with water. This oil, and an ointment made of the freshly-bruised plant, are in the London Pharmacopœia.

The leaves of the plant, in powder or infusion, and the oil, are often given with a view to procure abortion; but it has more frequently proved fatal to the mother than effectual in destroying the child. Savin is also in occasional use as a vermifuge.

Symptoms.—Those of irritation of the alimentary canal. There is severe pain in the belly and vomiting, and sometimes strangury, but diarrhœa is rare. Salivation and insensibility are among the occasional symptoms.

Post-mortem Appearances.—Those of acute inflammation of the alimentary canal; and the green powder is often found mixed with the contents of the stomach and bowels. On drying and rubbing this powder it gives out the peculiar odour of the plant, and the hard thick parts of the twigs exhibit under the microscope the ordinary characteristics of coniferous wood. Watery solutions of savin yield a deep-green colour with the permuriate of iron.

The *treatment* of poisoning by savin is that proper to the whole class of irritants (p. 318).

3. Yew (Taxus baccata).—The leaves and berries of this tree are poisonous. The leaves have proved fatal to animals, and the leaves and berries to man. The leaves, in substance or in infusion, are sometimes given as a vermifuge or abortive.

Symptoms.—Those of irritant poisoning, with the addition of nervous symptoms, such as insensibility and convulsions, which may perhaps justify us in classing the yew among the narcotico-acrids. Death seems to take place from collapse, when it happens in a short time; but if at a later period, the cause of death appears to be inflammation of the alimentary canal. The leaves have proved fatal to an adult in fourteen hours, and the berries to a girl five years old in four hours.

Post-mortem Appearances.—Those of irritation of the alimentary canal. The leaves or berries are generally found in the stomach, and may be identified by their shape and appearance. The leaves are lancet-shaped; and the berries, which are about the size of a pea, consist of a hard, brown, egg-shaped seed, surrounded by a colourless viscid juice, enclosed in a light red covering. The juice has an acid reaction and a nauseous taste.

4. Mezereon (Daphne mezereum).—This is a cultivated garden shrub, yielding a bright red berry, possessing highly irritating properties, and in large quantities acting as a poison. The berries, from their beautiful colour, attract the notice of children, and have been mistaken for currants. They contain a single ovate seed composed of two plano-convex cotyledons enclosed within the coat. Five or six of the berries

are sufficient to produce serious effects. The bark of the root is an ingredient in the compound decoction of sarsaparilla.

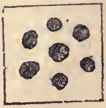
The *symptoms*, *post-mortem appearances*, and *treatment* are those of irritant poisoning.

5. ARUM (Arum maculatum, lords and ladies, cuckoo-pint).—The green spotted leaves of this plant, shaped like the head of an arrow, appear early in spring in hedge-rows, woods, and shaded spots, the green spathe, with its purple column enclosed, in May, and a cluster of bright-red berries alone, towards the end of summer. The root is tuberous and somewhat heart-shaped, and, in common with all other parts of the plant, is highly acrid and irritating. The juice applied to the tongue causes acute darting pain, as if it were pierced with sharp needles; and in the case of three children who ate of the leaves of the plant, the tongues were so swollen as to render swallowing difficult. Two of the children died in twelve and sixteen days respectively. The third recovered. The poisonous properties of the plant are wholly dissipated by heat; and the roots, first steeped in water, and then baked and powdered, constitute the "*Portland sago.*" The *symptoms, post-mortem appearances*, and *treatment* are those proper to irritant poisoning.

6. COLCHICUM (Colchicum autumnale, Meadow saffron).—This plant grows in moist meadows in every part of Europe. It flowers in autumn, and throws out its leaves in spring; and it has a fibrous root attached to the underside of an underground stem or corm. The fruit, which ripens about midsummer, contains a number of round seeds. The corm and seeds are used in making several preparations of the Pharmacopœia—the fresh corm for the extract, and acetic extract, the dried corm for the vinegar and wine, and the seeds for the simple and compound tinctures of colchicum. The corm has been taken by mistake for onions, and the seeds, wine, and tincture have also been taken in poisonous doses.

The *symptoms* are sometimes slow in showing themselves, even when large doses of the wine or tincture are taken; but in other cases they begin almost immediately, and death may take place in as short a time as seven hours. The symptoms are those of irritation of the alimentary canal, with collapse. Nervous symptoms are of rare occurrence. The *post-mortem appearances* are those common to simple irritant poisoning; and the *treatment* is that proper to poisoning by the irritants (p. 318), with the addition of the free use of stimulants to counteract the extreme debility.

Fig. 15.



The seeds of colchicum are round in shape, brown in colour, hard, and shrivelled on the surface. They are of the size figured in the annexed woodcut, and weigh eight, ten, or twelve to the grain.

Colchicum owes its poisonous properties to an alkaloid, allied to veratria, and named *colchicina*, of which less than half a grain has proved fatal to an adult.

HELLEBORE.—There are several species of hellebore—the Helleborus niger, viridis, and fœtidus, and the Veratrum album, or white hellebore. Two of these, the Veratrum album, and the Helleborus niger, are of some importance as poisons.

7. VERATRUM ALBUM (White hellebore).—This plant is not indigenous. Its rootstock and radicles are employed in making the Vinum Veratri of the Pharmacopœia. Every part of the plant is poisonous; but the powder of the root, or an infusion made from it, is the preparation which has been most commonly taken as a poison. This powder, which somewhat resembles powdered jalap in colour, has an acrid, bitter taste, and strongly irritates the nostrils. It is, accordingly, sometimes used, mixed with starch, as an errhine; but its principal use is to destroy vermin on the skin or hair.

The *symptoms*, *post-mortem appearances*, and *treatment* are those proper to irritant poisoning (p. 317), with a tendency to death by collapse. As little as 20 grains of the powder has destroyed life in three hours. It owes its poisonous properties chiefly to the alkaloid veratria.

VERATRIA.—This alkaloid is contained in the seeds of the Asagræa officinalis (Cebadilla), as well as in the rootstock of the Veratrum album. It is prepared from the seeds of the Asagræa, and is in the London Pharmacopœia. It violently irritates the nostrils and skin, and is applied externally in small quantities, and given internally in doses of $\frac{1}{12}$ grain. Even in this small quantity it requires to be used with caution. One-sixteenth of a grain is believed to have produced a state of dangerous collapse (Taylor). The alkaloid veratria is sold as a powder. It is not crystallizable. It burns away without residue, is nearly insoluble in cold, and sparingly soluble in hot water, sparingly soluble also in ether, but readily dissolved by alcohol. It has a slight alkaline reaction, forms soluble salts with the acids, and is slightly reddened by nitric acid, and changed to a deep crimson by sulphuric acid.

8. HELLEBORUS NIGER (Black hellebore, Christmas rose).—This plant derives its name from the dark or black colour of its root. Hence, also, the name "Melampodium" of the old Pharmacopœias. It grows in shady woods, and flowers in January, as the 'Christmas rose.' The leaves and roots are both poisonous; and the powdered root is a brisk purgative, and, as well as the leaves, is a favourite but dangerous worm-medicine with the vulgar. The tincture of hellebore is officinal.

The *symptoms*, *post-mortem appearances*, and *treatment* are those proper to irritant poisons generally (p 317), with violent action on the bowels, and marked symptoms of collapse.

9. *Diseased and decayed vegetable matters.*—A few cases have occurred of poisoning by spoiled vegetables; and bread made of wheat, rye, or barley, when spoiled or mouldy, has been known to act as an irritant poison, causing flushed face, dry tongue, violent colic pains,

urgent thirst and headache, vomiting and diarrhœa, exhaustion and drowsiness. These poisons are classed by Dr. Christison with the narcotico-acrids, to which class the ergot of rye certainly belongs.

Besides the vegetable irritants briefly noticed in this chapter, there are others of less importance, of which it must suffice to append a list. Some of them have produced the effects of irritants in the human subject, and have proved fatal, while others are inferred to be poisonous from their effect upon animals, or from direct experiment. A minute description of these poisons and of their effects must be sought for in works on toxicology. Most of them will be found figured, with brief descriptions of their effects, in Johnson's 'British Poisonous Plants.' The following is the list in question:—Anemone pulsatilla, or pasque flower, (also the A. nemorosa, A. hortensis, and A. coronaria, with other species,); Bryonia dioica, red-berried, common, or white bryony; Tamus communis, or black bryony; Caltha palustris, or marsh marigold; Chelidonium majus, or celandine; Daphne laureola, or spurge laurel; Euphorbia lathyris, or caper spurge (also other species, as the E. peplus, and E. helioscopia); Helleborus viridis, or green hellebore; Hyacinthus nonscriptus, or wild hyacinth; Mercurialis perennis, or dog's mercury; Narcissus poeticus, or narcissus; Ranunculus acris, bulbosus, sceleratus, and other species of the crowfoot, or buttercup; and the Sambucus nigra, or elder.

Besides the foregoing, which are indigenous plants, the Jatropha curcas, or physic nut of the West Indies; and the Hippomane mancinella, or manchineel, with other species of the same (as the H. figlandulosa, and H. spinosa), may be mentioned as possessed of highly irritating properties. (See Christison, chapter on Vegetable Acrids.)

CHAPTER VIII.

ANIMAL IRRITANTS.

1. CANTHARIDES.
2. POISONOUS FISH.
3. DISEASED AND DECAYED ANIMAL MATTER.

AMONG the poisonous substances derived from the animal kingdom some possess independent properties, others owe their poisonous effects to a change wrought by putrefaction. Of the first class cantharides is the principal member. Poisonous fish occupy a less important position. To the second class belong the several kinds of diseased and decayed animal matter.

1. *Cantharides.*

The Cantharis vesicatoria, Spanish fly, or blister beetle, distinguished by the shining golden green colour of the head, legs, and wing-cases, furnishes a very active irritant poison. It is the active ingredient of several preparations of the London Pharmacopœia—of the tincture which is administered internally; and of the acetum, ceratum, unguentum, and emplastum cantharidis, which are applied externally. It is characterized by its energetic action on the urinary and generative organs. The powder and tincture are given to procure abortion, for lascivious purposes, or merely by way of a joke; and both powder and plaster have been taken by mistake. It has also produced severe effects when applied externally.

When it has been administered in powder, the blistering fly may be detected in the contents of the stomach by the glistening golden or green colour of some of the particles, which may be readily seen by the lens or under the microscope; or it may be dissolved in ether or chloroform, evaporated to the thickness of an extract, and applied to the skin, or to the lip. If a blister is raised, it gives convincing evidence of the presence of cantharides. By these two tests Barruel succeeded in detecting cantharides in some cakes of chocolate, of which a part had been maliciously given to several persons.

The fly owes its poisonous property to an alkaloid, *canthàradin*, of which one grain is afforded by half an ounce of the powder; and the one-hundredth part of a grain will raise blisters on the lip. The chemical properties of this principle are not characteristic.

Symptoms.—Soon after swallowing the poison, a burning pain and

constriction of the throat, speedily followed by a similar burning pain in the pit of the stomach, increased by pressure, and extending at length over the whole abdomen, accompanied by excessive pain in swallowing, dryness of the fauces, great thirst, copious discharge of blood or bloody mucus from the stomach, mixed with shining, green particles, and, in less quantity, from the bowels; tenesmus, pain in the loins, distressing strangury, bloody stools and urine, priapism, with swelling, and inflammation of the genital organs. The patient is extremely restless, the breathing laborious, the pulse quick and hard. Occasionally headache, delirium, and convulsions, and coma are superadded.

Among the occasional symptoms recorded are blisters of the mouth, salivation, vomiting of tenacious mucus taking the shape of the gullet, or of the mucous membrane itself, redness of the eyes, and lachrymation, nausea, and an albuminous state of the urine.

When given as a medicine, in the form of tincture, small doses, such as four or five drops, produce a marked effect on the urinary organs, curing incontinence of urine, sometimes without causing pain. On the other hand, very large quantities, as six ounces of the tincture, or two drachms of the powder, have been taken without bad effect, a fact only to be accounted for by the badness of the preparation.

The smallest quantity of the tincture which has proved fatal is one ounce, and two doses of the powder of twenty-four grains each, taken at an interval of a day, have destroyed life after producing abortion.

Post-mortem Appearances.—These correspond with the symptoms just detailed. There are marks of inflammation in different degrees and stages in the whole length of the alimentary canal, and in the urinary and genital organs. The stomach is sometimes inflamed in patches, where the powder has adhered. The brain has been found gorged with blood. The powder may be found in the stomach for long periods after death. According to Orfila and Leseur, it may be found unchanged after an interment of nine months.

Treatment.—There is no antidote to this poison. Vomiting must be excited and encouraged by emetics and warm liquids; and the poison must be removed from the bowels by full doses of castor oil. The free use of diluents, with oily or demulcent injections into the rectum and bladder, and leeches or bleeding, if the inflammatory symptoms run high, constitute the remainder of the treatment. Laudanum may be advantageously added to the injections, or suppositories of opium may be introduced into the rectum.

2. *Poisonous Fish.*

Several kinds of fish belong to the class of irritant poisons. Some of these are constantly poisonous, others occasionally so, and others, again, act injuriously on certain persons only.

The most important of these poisonous fish is the common *mussel*, which becomes poisonous in certain circumstances not yet well under

stood. The symptoms generally come on after an interval of one or two hours, with swelling and itching of the eyelids, and watering of the eyes, and an eruption on the skin, in most cases closely resembling common nettle rash, and attended with intense heat and itching. Dyspnœa generally follows, but occasionally precedes these symptoms; there is extreme weakness; and in fatal cases delirium, convulsions, and coma have supervened. Symptoms of irritation of the stomach are not always present, but in some instances there have been nausea, pain in the pit of the stomach, vomiting, and difficulty in swallowing.

The treatment will consist in the free use of emetics, purgatives, and diluents. Ether may also be given with advantage.

Instances are on record in which oysters, eels, and salmon have produced injurious effects. The richer fish also habitually disagree with some persons. When fish owe their poisonous properties to putrefaction, they belong to the next class of poisons.

3. *Diseased and Decayed Animal Matter.*

There is a disease prevalent among cattle on the Continent, but less known in England, which consists in the formation of large boils upon different parts of the body. The flesh of animals which have died of this disease has often produced severe effects by contact with the skin, and when eaten has destroyed life either by producing violent cholera, or by creating a similar disease to that under which the animal laboured. The glanders communicated to man from the horse, and the diffuse inflammation excited by punctured wounds inflicted in dissection, or in preparing meat for the table, are familiar examples of the effect of diseased animal matter applied externally to the human body.

Decayed Animal Matter is a common cause of severe and dangerous symptoms allied to those of irritant poisoning. The articles of food which have most frequently acted as poisons are sausages (especially those made of liver and blood), bacon and ham, cheese, and goose grease.

The symptoms rarely come on till the lapse of three or four hours. In some instances the irritation of the alimentary canal is accompanied by symptoms of collapse, in others by narcotic symptoms, which would perhaps entitle these poisons to a place among the narcotico-acrids.

It appears that the poisonous quality of the food is developed only in the first stages of putrefaction, but disappears when that process is far advanced.

The milk of cattle fed in particular pastures, containing poisonous plants, is said to acquire poisonous properties, just as the honey of bees, which feed on certain poisonous flowers, produces delirium and symptoms of narcotic poisoning.

The treatment of these cases, after the removal of the poison from the stomach, would be determined by the nature of the symptoms present.

CHAPTER IX.

IRRITANT GASES.

1. Nitrous-acid Gas. (See p. 335.)
2. Sulphurous-acid Gas.
3. Hydrochloric-acid Gas.
4. Chlorine.
5. Ammonia. (See p. 343.)

The irritant gases have the common property of irritating and inflaming the eyes, throat, and whole extent of the air-passages. In a concentrated form they may produce fatal spasm of the glottis.

2. *Sulphurous-acid Gas.*

This gas possesses highly-irritating properties. It is one of the products of the combustion of common coal, and contributes to the fatal result when coal is burnt in close apartments. It is also the chief cause of the irritating gusts which issue from the baker's oven, and as such contributes to produce the diseases of the chest to which the London bakers are peculiarly liable.

3. *Hydrochloric-acid Gas.*

From experiments made on plants by Drs. Turner and Christison, and from experiments on small animals by Messrs. Rogerson (see chapter on Poisonous Gases in 'Christison on Poisons'), it is evident that this gas is possessed of highly-irritating properties, and that if inhaled by the human subject it would destroy life, as certainly as any other of the irritating gases.

4. *Chlorine.*

This gas is largely used in bleaching, and, in the sick room, as a disinfectant. It has highly-irritant properties, and produces violent irritation in the eyes, nostrils, air-passages, and throat. In a case cited by Christison, great relief was obtained by the inhalation of a small quantity of sulphuretted hydrogen gas.

From information collected by Christison, it appears that men who are in the habit of inhaling air impregnated with chlorine become gradually accustomed to its use, though they suffer from dyspeptic complaints and acidity, and lose flesh; but nevertheless many of them attain to an advanced age.

CHAPTER X.

SPECIFIC IRRITANTS.

This group comprises the metalloidal poisons and their compounds, and the preparations and compounds of most of the metallic poisons. The salts of some of the metals, such as zinc, appear to be simple irritants, and not to occasion any remote specific effects. But as they belong to the class of metallic poisons, it has not been thought expedient to separate them from the more important members of the same class. The leading poisons belonging to this class are treated in separate chapters. The metalloidal poisons, phosphorus and iodine, are treated in the present chapter.

1. PHOSPHORUS.

Properties.—It is usually found in the shops as small cylinders, preserved in water. It has the consistence and appearance of wax, is insoluble in water, but soluble in oils, in alcohol, and in the ethers: also remarkably soluble in the bisulphide of carbon. It burns at a low temperature with yellow flame and dense white smoke, and is luminous in the dark. A paste, consisting of flour, sugar, and phosphorus, sometimes coloured with Prussian blue, is sold as a poison for rats. Phosphorus has been given medicinally in over-doses, and is often taken in France, and sometimes in England, as it exists on lucifer matches; but its property of shining in the dark, which it does not lose by admixture with articles of food, and its peculiar odour and taste, unfit it for the service of the murderer.

Symptoms.—Those of acute irritant poisoning (p. 317). The taste of the poison resembles that of garlic, and the breath has an odour of the same substance. The matters rejected from the stomach and bowels have the same odour, and they are sometimes distinctly luminous in the dark. In some cases the nervous system seems to be strongly affected; and, in one instance, the symptoms resembled those of hydrophobia. Irritation and excitement of the genital organs are among its occasional effects.

Post-mortem Appearances.—Those of acute irritant poisoning, including extensive destruction of the coats of the stomach, with softening, ulceration, and perforation. The contents of the alimentary canal are phosphorescent, and the effluvia from a body advanced in putrefaction have been observed to have the same property.

Poisonous Dose.—From one to three grains.

Period of Death.—In acute cases, a few hours. In one instance, four hours. In chronic cases life may be prolonged for several days.

Treatment.—After the stomach-pump or emetics, hydrate of magnesia suspended in mucilaginous drinks, followed by aperients of the

sulphate and carbonate of magnesia. The rest of the treatment is that of irritant poisoning (p. 318).

In the chronic form of poisoning by phosphorus, the patient wastes away under prolonged dyspepsia and diarrhœa, with hectic fever. Exposure to the vapour of phosphorus, in the process of making lucifer matches, causes severe irritation of the lining membrane of the air-passages, and leads to caries of the teeth and necrosis of the jaw. The discovery of the important fact that red, amorphous, or allotropic phosphorus, though possessing the same chemical composition, is not poisonous, may lead to the disuse of common phosphorus for manufacturing purposes. The substitution of chlorate of potash is, however, to be preferred.

Phosphorus in Organic Mixtures.—Several methods for detecting the poison have been proposed. Mitscherlich adds to the organic matter water, and a small quantity of sulphuric acid, and distils it in the dark from a flask, through a tube kept cool by a stream of water. At each condensation of the vapours in the tube a luminous appearance is perceived. Another plan consists in converting the phosphorus into phosphoric acid, by boiling with nitric acid diluted with three parts of water. A third plan, suggested by Dr. Taylor, consists in digesting the organic matters in bisulphide of carbon, and allowing the solution to evaporate spontaneously. The phosphorus remains in the form of small globules, which sometimes take fire spontaneously. ('On Poisons,' 2nd edit., p. 350.)

2. IODINE.

Properties.—This is a scaly substance, not unlike iron filings in appearance, of a peculiar and disagreeable odour, giving off irritating violet fumes when heated, striking a fine blue colour with a solution of starch, and staining the skin and lining membrane of the intestinal canal a yellowish brown, which stain is removed by liquor potassæ. It is found in the shops in substance, as a tincture, and as a compound solution with iodide of potassium as a solvent. It is largely used in medicine as an external application, and internally in combination with potash, as iodide of potassium.

Symptoms.—A disagreeable acrid taste, with a sensation of heat, dryness, and constriction in the throat, in the act of swallowing, followed by the symptoms of acute irritant poisoning (p. 317). The discharges, of a deep yellow tint, are often mixed with blood.

In chronic poisoning, produced by the prolonged employment of iodine or its preparations in medicinal doses, the symptoms, in addition to those of irritation of the alimentary canal, are tremors, palpitation, gradual absorption of the testicles, mammæ, and other glandular structures, ptyalism, increase of almost all the secretions, priapism, and enlargement and tenderness of the liver. These symptoms, which are not present in all cases of *iodism*, have been more than once produced by small doses, administered for a few days at a time.

Post-mortem Appearances.—Those of acute irritant poisoning (p. 317). Enlargement of the liver.

Treatment.—That of irritant poisoning (p. 318), including the free use of a weak solution of carbonate of soda, and of diluents containing starch, such as arrow-root.

3. IODIDE OF POTASSIUM (*Hydriodate of Potash*).

Properties.—Iodide of potassium is a crystalline substance, having a peculiar faint odour. Its crystalline form is a cube. The crystals, when pure, are white, permanent in the air, and very soluble in water and alcohol; but when impure, of a yellowish colour, and deliquescent.

Tests.—Strong nitric or sulphuric acid turns the crystals brown by liberating the iodine, which on the application of heat rises in violet vapours.

In Solution it has the following reactions:—corrosive sublimate yields a fine carmine-red precipitate, the iodide of mercury; acetate of lead, the yellow iodide of lead; the subnitrate of mercury, the yellow subiodide of mercury, which gradually changes to a dirty brown; sulphuric and nitric acids change the solution to a brown; and, on the addition of starch, to a characteristic blue. The base may be detected by the bichloride of platinum.

In Organic Mixtures.—Transmit sulphuretted hydrogen through the mixture to convert free iodine into hydriodic acid. Drive off the excess of gas by a gentle heat, add potash in excess, filter, and evaporate to dryness. Place the residue in a covered crucible and char it at a low red heat; reduce the charred mass to powder, treat it with distilled water, and filter. Concentrate the liquid by evaporation, and apply the test of starch and sulphuric acid. By this means very minute quantities of the poison may be detected.

Symptoms.—When given as a medicine, and in small doses, the hydriodate of potash sometimes acts injuriously, in consequence of peculiarity of constitution. Alarming symptoms have been produced by two or three doses of two or three grains, or a single dose of five grains; but the medicine is being constantly given in five-grain doses three times a day to large numbers of patients, without producing any bad effects. The symptoms are vomiting and purging, severe griping pains in the abdomen, watering at the nose and eyes, swelling of the face, headache, dryness of the throat, intense thirst, difficulty of breathing, frequent pulse, and great prostration of strength. In less marked cases the symptoms resemble those of a severe cold. Ptyalism is an occasional symptom. In one case, in which I ascertained that no preparation of mercury had been given, all the characters of mercurial salivation were present,

Treatment.—The poison should be promptly removed by the use of emetics, or by the stomach-pump. The after-treatment is by diluents, with antiphlogistic remedies if necessary.

CHAPTER XI.

1. ARSENIC AND ITS PREPARATIONS.
2. ANTIMONY AND ITS PREPARATIONS.
3. MERCURY AND ITS PREPARATIONS.
4. LEAD AND ITS PREPARATIONS.
5. COPPER AND ITS PREPARATIONS.
6. ZINC, TIN, SILVER, IRON, BISMUTH, CHROME, AND THEIR PREPARATIONS.

ARSENIC is by far the most important of the metallic poisons, whether we measure its importance by the extent to which it is diffused, the number and variety of its applications in medicine and the arts, or the frequency of its use as a poison.

Arsenic and its compounds enter largely into the composition of the earth's crust. It is found as metallic arsenic, as arsenious acid, in the form of the two sulphides, realgar and orpiment, and as a constituent of several ores of iron, copper, silver, tin, zinc, nickel, and cobalt. The greater part of the arsenious acid of commerce is prepared from an arsenical sulphide of iron, known as mispickel, or arsenical pyrites; the remainder from the roasting of ores containing arsenic, especially those of copper and cobalt.

The vapours of arsenious acid are diffused in the atmosphere, in large quantities, in the neighbourhood of some smelting furnaces. Arsenic has also been found in several soils, in plants grown upon them, and in some mineral waters and running streams.

As the iron pyrites, or *mundic*, which is so largely employed in the manufacture of oil of vitriol, contains arsenic as an impurity, much of the sulphuric acid of commerce is tainted with arsenic; and this being, in its turn, very largely used in the manufacture of nitric, hydrochloric, and other volatile acids, of sulphate of soda, as a preliminary to the making of the carbonate of soda, and for other purposes, many liquid and solid substances in common use in medicine and the arts are impregnated with arsenic. In the application of the tests presently to be described, the two metals, zinc and copper, the two acids, the sulphuric and the hydrochloric, and the sulphuret of iron have all been found to contain arsenic. Arsenic acid and the alkaline arseniates are in use as mordants, and in some dye-works to such an extent as to poison the waters of the streams into which they discharge their refuse; and even to taint the water-supply of towns.

Arsenious acid, the most important of the compounds of arsenic, is very largely employed in the arts. It is used in the manufacture of glass, to improve the quality of the "metal," and in the making of white enamel. Farmers use it to preserve grain for seed, and many

of the dipping compounds for sheep owe their efficacy to the large quantity of arsenious acid which they contain. Grooms give it to horses to improve their coats; and there is no longer any doubt that some Styrian peasants habitually take arsenious acid in quantities exceeding the smallest poisonous dose.* Shipbuilders mix it with tar to protect timber from worms. It is largely employed to kill rats and vermin, flies, and moths. It has long been used in the manufacture of composition candles, and recently to prevent the furring of steam-boilers.

The metal arsenic is mixed with lead in small shot.

The preparations of arsenic have been mixed by accident, or in ignorance, with articles of confectionary: arsenious acid with lozenges, orpiment in Bath buns, and Scheele's green with blancmange. Scheele's green is also very largely used in the manufacture of green papers.

Arsenical preparations are administered internally, in Fowler's solution, and the liq. arsenici chloridi, for the cure of ague and intermittent disorders, and of obstinate skin diseases; and white arsenic mixed with large quantities of calomel, or otherwise minutely subdivided, is sometimes applied externally in lupus and cancer.

The preparations of arsenic which are of most interest in a medico-legal point of view are, the white oxide or arsenious acid, the yellow sulphuret or orpiment, the green arsenite of copper or Scheele's green, and the arsenite of potash contained in Fowler's solution. Of these the arsenious acid is by far the most important; and it will have to be examined, accordingly, with great care, and in much detail.

As all our processes of analysis include the production of the metal arsenic as a means of identification, it will be expedient to preface the examination of the several preparations of arsenic by some account of the most important properties of the metal.

The *metal* arsenic sublimes at the low temperature of 356° Fahr. When the sublimation is conducted in close vessels, it is deposited on cooler surfaces unchanged; but when heated in contact with air it is deposited as the white oxide, or arsenious acid, or as a mixture of the acid with the metal. The metal is also deposited unchanged when it is sublimed in an atmosphere of carbonic acid. The metal in subliming gives out the odour of garlic. It shares with antimony the property of combining with nascent hydrogen, to form the arseniuretted hydrogen gas, which gas, when heated or burned, gives up the pure metal to cool surfaces; and it shares with several other metals the property of being reduced and deposited on copper boiled in an acid liquor containing any of its preparations.

All these properties of metallic arsenic are displayed in operations on the small scale, in which we use the spirit-lamp and small reduction-

* Dr. Roscoe, in a paper read to the Manchester Philosophical Society, Oct. 30, 1860, brings forward conclusive evidence in support of this statement, and adduces well-authenticated instances in which the poison was swallowed to the amount of 4½ and 5½ grains at a time.

tube. The vapour of the metal has the garlic odour: it is deposited on cooled surfaces as arsenious acid, when the tube contains atmospheric air; and as pure metal when it is filled with carbonic acid gas: it forms a shining metallic crust or stain on a surface of porcelain when the burning jet of arseniuretted hydrogen is directed upon it from Marsh's apparatus; it leaves a similar stain in the tube through which the gas is transmitted, when heated by the spirit lamp; and it forms a metallic coating to copper foil when boiled in liquids containing it and acidulated with hydrochloric acid, according to Reinsch's process. The vapour of the pure unmixed metal is deposited on cooled surfaces as minute globules, closely resembling those of mercury (fig. 15); but when air is present in such quantity as to oxidize part of the vapour, the globules of metal are blended with the white powder or transparent crystals of arsenious acid.*

Fig. 15.

ARSENIOUS ACID (*Oxide of Arsenic, Sesquioxide of Arsenic, White Oxide of Arsenic, White Arsenic, Arsenic*†).

In the two years 1837 and 1838, arsenious acid was the ascertained cause of 185 deaths, being as many as those attributed to all the preparations of opium, and considerably more than those caused by all the other poisons. Of these 185 deaths, 112 were ascertained to have been suicidal, 21 accidental, and 12 homicidal; but the homicidal deaths from this cause were probably much more numerous.

Since the act of 1851 (14 Vict., cap. xiii.), which restricted the sale of arsenic, and prescribed its admixture with soot or indigo when sold in small quantities, it is probable that cases of poisoning by arsenious acid have become less numerous, both absolutely and relatively to other poisons. In the two years 1837, 1838, it was, as has just been stated, the cause of 185 deaths. This was out of a total for those years of 543 deaths by poison. But in the five years 1852-56, it gave rise to 27 only of the annual average of 268 deaths by ascertained poisons. In the first period, therefore, the proportion was 1 in 3, or 34 per cent., in the second period 1 in 10, or 10 per cent. In France arsenious acid takes still higher rank as a poison.

The common use of arsenious acid as a poison will excite no surprise when it is borne in mind that it is as white as flour, that it is tasteless or nearly so, that it may be mixed with articles of food without undergoing or causing any change, that it is very cheap, and that it is in common use, as has just been stated, for a great variety of purposes.

Arsenious acid is found in commerce as a solid cake, and as a white powder. The cake, when first sublimed, is nearly transparent, but

* Refer to a paper by the author, 'On the Production and Identification of Crystals of Arsenious Acid and Crusts of Metallic Arsenic,' in Dr. Beale's 'Archives of Medicine,' No. 111, 1858.

† In some country places it is known as "Mercury"!

becomes opaque by keeping, and resembles white enamel, interspersed with thin transparent striæ. It is the powder which is ordinarily used as a poison. Arsenious acid, in either of these forms, has well-marked physical properties, and may be readily identified by chemical tests.

Properties.—1. Arsenious acid is sparingly soluble in water, hot or cold. 2. The solution has a very slight acid reaction. 3. In substance it is tasteless, but its solution or vapour has a very faint sweet taste. 4. The solution of the acid in boiling water, when slowly evaporated, deposits well-formed octahedral crystals. 5. It is very soluble in ammonia, in hydrochloric acid, and in carbonate of potash; and it is deposited from its solutions in ammonia and hydrochloric acid, also as octahedra. 6. It combines with alkalis, forming soluble arsenites.

Two of these properties, the *solubility* and the *taste*, require to be more minutely examined.

Solubility of Arsenious Acid.—Cold water dissolves from half a grain to a grain to the ounce; boiling water poured on the poison retains on cooling one grain and a quarter to the ounce; and water boiled for an hour on the powder retains on cooling 12 grains to the ounce. But the presence of organic matter renders the poison less soluble. (Taylor.)

Taste of Arsenious Acid.—The poison was formerly described as having an acrid taste, but this statement is now acknowledged to be incorrect. The powder has scarcely any taste; if any, a very faint sweet taste. This sweetness is more perceptible in solution, and still more so in vapour.*

Tests.—We may have to identify arsenious acid, 1. In substance 2. In solution. 3. In organic liquids; and, 4. In the fluids and solids of the body.

1. *Arsenious Acid in Substance.*

a. When heated by the spirit lamp on platinum foil, it sublimes unchanged, as a white vapour. *b.* When heated in a reduction-tube, it is deposited either as an amorphous powder or as octahedral crystals. *c.* When moistened by liquor potassæ it undergoes no change of colour. *d.* When moistened by sulphide of ammonium, no immediate change of colour takes place; but, after a time, when the excess of ammonia has evaporated, a canary-yellow sulphide of arsenic is formed. This change may be brought about directly by heat, or by the addition of acetic acid. *e.* When the arsenious acid is mixed with charcoal and heated, the metal is reduced and volatilized; and if a reduction-tube be employed for this

* Otto Tachenius, in his *Hippocrates Chemicus*, says, "that after many sublimations of arsenic, on opening the vessel, he sucked in so grateful and sweet a vapour, that he greatly admired it, having never experienced the like before." See Baker's 'Employment for the Microscope,' p. 133. The tastelessness of the powder is proved by the case of a lad who took from the mouth of a bottle as much arsenious acid as would cover a sixpence, and who told me that it tasted like flour.

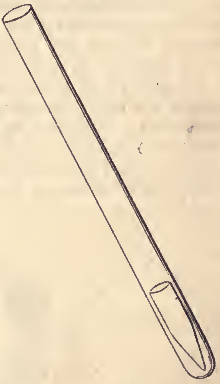
purpose, the metal is deposited on the cooled sides of the tube as a shining metallic crust. *f.* The vapour has the characteristic garlic odour.

Of these tests there are two which require to be more exactly described, and their results more minutely examined. These are the test of sublimation and the test of reduction.

Sublimation.—It has just been stated that arsenious acid, when heated by the flame of a spirit-lamp in a glass tube, is converted into a white vapour; and that this vapour is deposited on the sides of the tube either as an amorphous powder, or as octahedral crystals. But as it is the crystals which are characteristic of the poison, and not the white amorphous deposit, it is necessary to explain by what mode of manipulation the crystalline deposit may be obtained. Now experience has proved that in order to the development of characteristic crystals of arsenious acid the white vapour must be received on a heated surface. On a cool surface it deposits itself as an amorphous powder.

The process of sublimation is usually performed in a reduction-tube of green glass of about the size and length shown in fig. 16. After drying the tube by passing it repeatedly through the flame of the spirit-lamp, the arsenious acid is to be conducted to the sealed end through a smaller glass tube, or by means of a gutter of paper, so as to avoid soiling the sides of the tube. The middle portion of the tube should then be heated and the flame of the lamp immediately transferred to the sealed end. The vapours as they rise will be deposited on the heated part of the tube as crystals, and on the cooler portion of the tube as an amorphous powder.

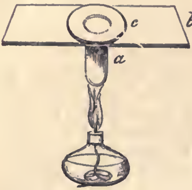
Fig. 16.



One object contemplated by the process just described is so to introduce the arsenious acid as to keep the sides of the tube clean. For this purpose, as well as for obtaining well-formed crystals, the following modified process is to be commended: — Take two small tubes of glass (green or white), of which the one shall be large enough to inclose the other. Shape the larger into the reduction-tube, fig. 16, and the smaller into the shorter tube, shown in the same figure. Introduce the arsenious acid into the short tube, and drop it into the reduction-tube. Apply the flame of the spirit-lamp so as to envelope the lower third of the tube. By the time that the temperature of the inner tube is so raised as to sublime its contents, that of the outer tube will be favourable to the deposit of the vapour in the form of distinct crystals.

This method of sublimation, in common with all similar methods, is open to the serious objection that the crystals cannot be conveniently examined through the thick round sides of the tube by means of the lens or microscope; and this objection applies with great force to minute crystals obtained from small quantities of the poison. To obviate this objection I have proposed the following method:—Take a small, clean, dry specimen-tube, *a*, of white glass, of about twice the length and size shown in fig. 17, drop it into a hole in a slab of porcelain or brass, *b*, and hold it in a vertical position. Let the arsenious acid fall to the bottom of the tube. Then hold a disc, *c*, of thin crown glass of the size of a crown-piece in the flame of the spirit-lamp till it is quite dry and hot: place it at once over the mouth of the tube, and immediately apply the point of the flame of the lamp steadily to the bottom of the tube, till the lower surface of the glass disc is covered with glittering crystals. As soon as the crystals are seen to form on the disc, withdraw the lamp. Repeat the operation with other discs.

Fig. 17.



By this method crystals may be obtained from the smallest visible speck of arsenious acid, and, being upon a flat surface, may be conveniently examined by the lens or microscope. Excellent results of extreme delicacy may also be obtained by a similar method of procedure presently to be described. (See fig. 33.)

The crystals of arsenious acid obtained by these methods of sublimation are also procured by oxidation of the metal arsenic, as a constituent part of tests yet to be described; and as the crystals, however procured, always furnish a very important means of identification, their shape and characteristic properties ought to be well understood.

Crystals of Arsenious Acid.—These crystals are remarkable for their brilliancy and permanence. They are distinct and separate, except when superimposed, very rarely forming compound crystals of any definite shape. Their prevailing form is the regular octahedron, consisting of eight equilateral triangles joined at their edges. A section passing through four edges, and dividing the crystal into two equal parts gives a figure which is a perfect square. The crystal is shown in outline in fig. 18, and as it is occasionally seen under the microscope in fig. 19. But in every considerable group of crystals there are many modified and imperfectly-

Fig. 18.

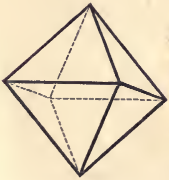
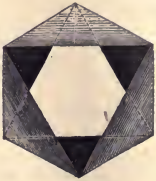


Fig. 19.

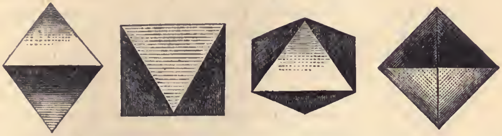


formed octahedra, together with some prismatic and other forms, concerning which it is necessary to give a few words of explanation.

The regular octahedron, it should be understood, presents itself to the lens and microscope under many different aspects, according as the crystal adheres by an angle, face, or edge, and according as the light traverses the crystal or is reflected from it. When the crystals are viewed by reflected light, or when the light passes through them so as to render them practically opaque, they present either two, three, or four sides, as in the annexed engraving (fig. 20), in which 1 represents a crystal resting on a face with an angle of the face pointing forward; 2, a crystal also resting on a face, but with the base of the triangle forward; 3, a crystal placed as 1, but differently viewed, and 4, a crystal attached by an angle, and with the opposite angle projecting forward.

Fig. 20.

1 2 3 4



But when the light is transmitted through the crystals these forms are modified and disguised by such shadows as those shown in fig. 21.

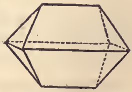
Fig. 21.

1 2 3 4 5 6

These shadows represent the remote inclined sides of the crystal, so that crystal 3 of the series displays four sides, crystal 6 five sides, and crystal 5 seven sides. It very rarely happens that the eight sides of the crystals are distinctly visible, as in fig. 19, in which the two equilateral triangles represent the parallel sides without shadow, and the three receding triangles and three dark triangular shadows complete the number.

Sometimes, in consequence of the indistinctness of the shadows of the receding sides, the crystal is seen as in 1, fig. 25, under the simple form of an equilateral triangle.

Fig. 22.



Sometimes the octahedron, instead of being moulded on a square, is built upon an oblong, so as to assume the form shown in fig. 22.

In all groups of well-developed crystals most of the forms just described and figured will be readily seen; but it should be understood, as has just been stated, that the octahedron is not always perfect. The opposite angles

are often truncated, as in No. 4, fig. 21; sometimes one angle only; sometimes all the angles. Again, the sides of the crystals are sometimes indented, and the angles rounded, as in fig. 23, so as to resemble a trefoil, and the crystal is sometimes fixed in such a position (2, fig. 21) as to be identified with difficulty.

Fig. 23.

Sometimes, too, the crystals are not only truncated or disguised by curtailment of their angles, sides, or edges, but they are imperfectly built up, so as to present several forms different from any of those figured above, but of very common occurrence in all groups of crystals. One of the most common of these forms is a black square without any perceptible markings, which would result from a half crystal attached by an angle, or possibly from 4, fig. 20. Five or six other forms frequently met with would result from a half crystal divided by a plane parallel to two of its faces, as in fig. 24. This half crystal yields the forms depicted in fig. 25, namely, 1, a simple equilateral triangle; 2, an equilateral triangle resting on half the adjoining triangle, as a base; 3, a simple hexagon; 4, a hexagon with three small equilateral triangles in shadow; 5, a truncated equilateral triangle; 6, a figure having the appearance of a triangular prism.

Fig. 24.

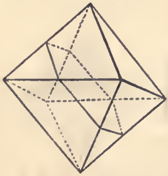
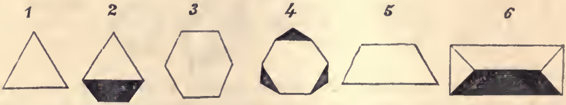


Fig. 25.



The twin crystals or *macles* (fig. 26) resulting from the juxtaposition of corresponding portions of the half crystal, shown in 6, fig. 25, are also not uncommon, and it is not unusual for these twin crystals to assume forms very easily mistaken for cubes.

Fig. 26.

In one instance I have seen the crystals built up into a rectangular prism, with the ends shaped into a short four-sided pyramid, and the length divided into two unequal parts by a line at right angles to the axis.

Sometimes when the heat of the surface on which the crystals are deposited is insufficient, all the crystals assume irregular and confused forms.*

* Those who desire fully to understand, or clearly to explain, the microscopic appearances of the crystals of arsenious acid should study those appearances on the larger scale by means of octahedra of wood and glass, referring at the same time to the 'Mineralogy and Crystallography' of Tennant and Mitchell.

Some of the many forms assumed by the crystals of arsenious acid, as seen under the microscope by transmitted light, are shown in fig. 27, as well as in fig. 13, where they are mixed with scattered globules of metallic arsenic; also in figures 29 and 30, where they are viewed by reflected light in mixed crusts of arsenious acid and metallic arsenic.

Fig. 27.

Reduction.—This process is commonly effected in the tube of green glass represented in fig. 28. The arsenious acid, well mixed with about four times its bulk of finely powdered recently ignited charcoal, is introduced into the tube at *a*, with the precautions just described in speaking of the process of sublimation, with this difference only, that it is not necessary to heat the middle portion of the tube. On applying the heat of the spirit-lamp steadily to the sealed end of the tube held at an angle of 45°, the metal rises in vapour, with the odour of garlic, and is deposited on the sides of the tube from a quarter to half an inch above the mixture, as a dark brown or black ring, *b*. As the vapour of the metal rapidly attracts oxygen from the atmosphere, it is readily reconverted into arsenious acid. Hence the ring is always a mixture, in variable proportions, of metallic arsenic and arsenious acid. The lower portion of the ring consists chiefly of metal, and has the appearance of a mirror; the portion immediately above it contains a larger admixture of arsenious acid, and the highest portion may consist almost wholly of the acid. By cautiously applying the flame of the lamp to the lower portion of the ring, it may be rendered more compact and more distinctly metallic; and by driving the crust repeatedly up and down the tube, it may be wholly converted into arsenious acid, in the form of octahedral crystals.

Fig. 28.

When this process of reduction is performed with proper precautions (using a tube of green or German glass that the glimmer of lead reduced in the glass itself may not be confounded with the crust of metal;* taking care that the mixture of arsenious acid and charcoal and the sealed end of the tube itself are free from moisture, so that the mixture may not be driven up into the tube; taking equal care to

* The objection formerly advanced that the arsenious acid sometimes used in the manufacture of glass might be reduced, so as to create a glimmer in the glass, is now abandoned.

introduce the mixture so as not to soil the tube; and drying the tube itself after its introduction) very satisfactory results are obtained. The mixed crust thus procured cannot be mistaken for globules of mercury; nor can it be confounded with the crust obtained by the same process from the white hydrated oxide of cadmium, as the anhydrous oxide of cadmium blended with the crust has a brown, green, or yellow colour.

But as it may always be alleged that the metallic crust obtained by this process of reduction does not present of itself such distinct characters as to justify a witness in affirming that it is due to arsenic and to nothing else, it is always deemed necessary to submit the crust to further manipulation. This is done in one of two ways. The sealed end of the tube containing the residue of the charcoal is drawn off, and the metallic crust driven up and down the tube till the metal is changed into the oxide, and deposited as octahedral crystals on the side of the tube; or the sealed end of the tube, as well as the part of it containing no deposit, are filed off, and the part containing the crust being folded in paper, is broken into small fragments, which fragments are introduced with like precautions into a second reduction-tube, and the metal converted into arsenious acid by heat. In either of these ways the evidence afforded by the reduction of the metal is confirmed by the production of the characteristic crystals of arsenious acid.

But this method of procuring crusts of metallic arsenic from arsenious acid and charcoal, and crystals of arsenious acid from the metal, is open to two classes of objections. The method itself is wanting in delicacy, and encumbered by many precautions, and the results present themselves in a form so unfavourable for examination that the more minute crusts and crystals cannot be identified with certainty. The use of the lens and microscope is in all cases rendered difficult, in some impossible. These considerations have led me to recommend the same simple apparatus for the reduction of the metal as that already described for the sublimation of the oxide, and shown in fig. 17.

The mixture of arsenious acid and charcoal is first dropped into the clean and dry specimen-tube (*a*); the disc of glass (*c*) is then held in the flame of the spirit-lamp till the moisture is driven off, and when cool is placed over the mouth of the tube. The point of the flame is then steadily applied to the bottom of the tube. The vapours of the metal when first disengaged from the mixture combine with the oxygen of the air contained in the tube, and arsenious acid is re-formed, which deposits itself on the under surface of the glass disc, as an amorphous powder, or in glittering crystals, according to the temperature. The after-deposit is in the metallic form.

The crust in this case, then, as in the usual process of reduction, is a mixed crust of metallic arsenic and arsenious acid. This crust, when examined by the lens, or under the microscope by reflected light, has the appearance shown in fig. 29, where the sparkling triangular facettes of the octahedral crystals of arsenious acid are shown projecting through a layer of metal; or that depicted in fig. 30, where the

distinct octahedral crystals or masses of crystals are more or less thickly coated and obscured by a light brown or gray metallic deposit.

Fig. 29.

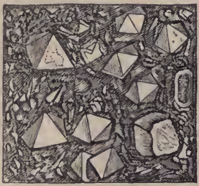
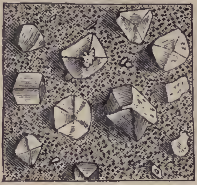


Fig. 30.



A third form assumed by some of the thinner crusts, and by the circumference of the thicker crusts, consists of crystals of arsenious acid interspersed with distinct globules of metallic arsenic, as in fig. 31. The thinnest crusts of all present an iridescent appearance, and may be resolved, under the higher powers of the microscope, into aggregates of small globules. Crusts of pure unmixed metal, presenting under the microscope the appearances shown in fig. 32, may be readily ob-

Fig. 31.

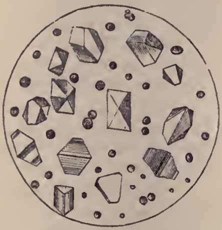
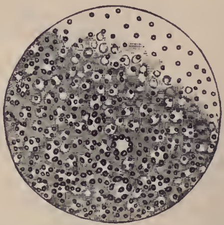


Fig. 32.



tained by covering the mixture of arsenious acid and charcoal with a layer of dried bicarbonate of soda, so as to fill the tube with an atmosphere of carbonic acid gas. See also fig. 15, p. 369.

The appearances presented by figures 29, 30, and 31, are quite decisive of the presence of arsenic. Those presented by the unmixed metal in fig. 32 are less conclusive, as the globules sometimes are not to be distinguished by their appearance from those of mercury. Hence it may be necessary in the case of the purer crusts of arsenic, and expedient in other cases, to confirm the evidence afforded by the microscopic characters of the metallic or mixed crust, by converting the metal into arsenious acid. With this view the portion of the glass bearing the crust must be cut into narrow slips with a writing diamond. The slips must then be introduced into a specimen-tube (fig. 17), and treated in the manner just described. The glass disc will be covered with glittering crystals,

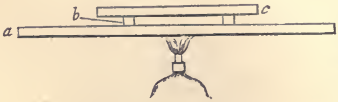
or with a mist which can be resolved, under the higher powers of the microscope, into groups of well-formed octahedra.

It may be well to state that the metals cadmium, selenium, and tellurium are, like the metal arsenic, sublimed by the heat of a spirit-lamp; that selenium is also deposited as globules, and tellurium sometimes converted into crystals of telluric acid. But crusts of selenium have the colour of port wine, the crystals of telluric acid are needles, and the metallic crusts of cadmium and tellurium do not consist of globules. The mixed crusts of arsenic are not to be confounded with any other result of sublimation, and are quite different in appearance from mixed crusts of cadmium obtained from a mixture of the white hydrated oxide with charcoal.

There is still one method of procedure especially applicable to such minute quantities of arsenious acid as the thousandth of a grain; and it is one that might without impropriety be comprised in the category of liquid tests. If on evaporating a drop of liquid supposed to hold arsenious acid in solution, a white non-crystalline stain is left, we may proceed to test it in one of two ways.

1. A drop of the liquid is to be evaporated on a porcelain slab *a*, upon which a ring of glass *b*, such as is used for making raised microscopic cells is placed, so as to enclose the stain. On this ring a glass disc *c*, is to be placed to receive the sublimed arsenious acid. Having heated this disc in the flame of the lamp, and placed it upon the glass ring, the flame is to be steadily applied to the porcelain slab beneath the stain, and withdrawn as soon as a mist appears on the disc. This mist, if examined by the microscope, will be found to consist of crystals of arsenious acid. In this way as small a quantity as the one-thousandth of a grain of arsenious acid may be identified without difficulty, and even the five-thousandth of a grain will be found to yield characteristic results.

Fig. 33.



2. But for combined delicacy and ease of application the following method is to be preferred.

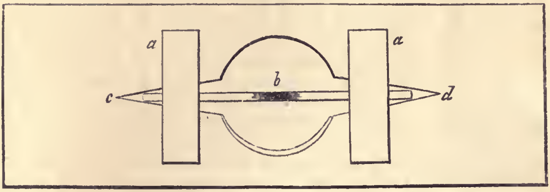
Take a fragment of microscopic glass, and mark it with a writing diamond, so that when broken it may yield narrow slips of glass. Place a drop of the solution of arsenious acid on the glass, let it dry,

Fig. 34.

and then break the glass into slips. Draw out a small tube of green glass *a a′* into the form shown in fig. 34; dry the tube by passing it

repeatedly through the flame of the spirit-lamp. Introduce the slips of glass into one of the open ends of the tube as at *b*. Seal the tube at *a*, and shake the slips down to the sealed end. Place the tube in a good side light, and, after heating the capillary portion of the tube, apply the flame of the lamp steadily to the sealed end. When the vapours of arsenious acid show themselves, move the flame cautiously towards the capillary portion of the tube till a white mist or stain appears, as at *e*. Now draw off and seal the capillary tube at *d d* and mount it for the microscope in the manner shown in fig. 35, which represents a card of the size of the common microscope slide with a central aperture enlarged by side cuts. The capillary tube *c d*, rests on a perforated label gummed to the back of the card and is confined to its place by the slips

Fig. 35.



of gummed paper *a a*. Write a memorandum of the date and circumstances of the reduction on the label. As the sides of the capillary tube *c d* are exceedingly thin, they offer no impediment to an examination of the stain *b*, with the higher powers of the microscope; and in this way the thousandth and two-thousandth of a grain of arsenious acid may be identified with certainty, and less quantities than the five-thousandth of a grain when the reduction is carefully and skilfully performed.*

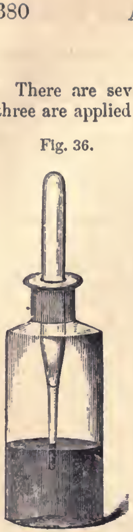
The same method of procedure is equally applicable to the reduction of the metal. The only modification required consists in substituting for a tube open at both ends a reduction-tube (fig. 16) sealed at one end. The mixture of arsenious acid and charcoal having been introduced into the small short tube shown in the figure, and this being placed in the reduction-tube, this last is then to be drawn out into a capillary tube, through which the sublimed arsenic is made to pass. The first part of the crust will generally be found to consist of metallic globules, the second of crystals of arsenious acid.

* To obtain these minute quantities proceed as follows:—Weigh a grain of arsenious acid in an accurate balance. Dissolve it in a thousand minims of distilled water. Take up the solution with a *pipette*, furnished with a small opening, or use the stoppered drop bottle (fig. 36, p. 380), which I recommend for all solutions and tests used in delicate chemical manipulations. Ascertain how many drops from the point of the pipette are equivalent to a minim. Say that there are three drops to a minim, then the stain left by the evaporation of a single drop will consist of $\frac{1}{3000}$ grain arsenious acid.

2. *Arsenious Acid in Solution.*

There are several tests for arsenious acid in solution. Of these three are applied in a liquid form, and are known as *liquid tests*; one in the form of gas, and may be distinguished as the *gaseous test*; a fifth is the well-known *Marsh's test*; and a sixth the now equally familiar test of *Reinsch*.

Fig. 36.



1. *The Liquid Tests.*—These are three in number:—the ammonio-nitrate of silver, the ammonio-sulphate of copper, and sulphuretted hydrogen water. *a.* The ammonio-nitrate of silver.* This throws down a rich yellow arsenite of silver, which on exposure to light, changes to a dingy brown. *b.* The ammonio-sulphate of copper† causes a precipitate of the bright green arsenite of copper. *c.* Sulphuretted hydrogen water throws down in strong solution a yellow precipitate of sulphide of arsenic. The sulphide of ammonium produces no immediate effect, but after a long interval, or on the addition of a few drops of acetic acid, causes the same precipitate.

These tests are supposed to be applied in succession to a clear colourless liquid believed to contain arsenious acid, and so applied, are free from objection; but it should be understood that a solution of phosphoric acid yields with ammonio-nitrate of silver a yellow precipitate, as an alkaline phosphate does with the simple nitrate of silver; and that a decoction of onions gives with the ammonio-sulphate of copper a green precipitate. As these liquid tests are only used as trial tests, or to prove that a white powder or crystals obtained from the oxidation of a ring of metal really consist of arsenious acid, these objections find no place.

The Gaseous Test.—This test, too, is supposed to be applied to a clear colourless liquid. Having ascertained that the liquid does not possess any decided acid or alkaline reaction, we transmit the sulphuretted hydrogen gas through the liquid slightly acidulated with acetic acid. If the liquid contains arsenious acid its colour is soon changed to a rich golden yellow. If the quantity of the arsenious acid is considerable, a precipitate of the same colour is formed; but if it is in small quantity, the precipitate is not formed until the excess of gas has been expelled by heat, and the liquid has been left at rest for several hours. The only other substances which yield with sulphuretted hydrogen a yellow precipitate are the peroxide of tin and cadmium, the one of

* The ammonio-nitrate of silver is formed by adding liquor ammoniæ to a strong solution of nitrate of silver, till the brown oxide of silver at first thrown down is nearly redissolved.

† The ammonio-sulphate of copper is formed in the same way by adding liquor ammoniæ to a solution of the sulphate of copper, till the bluish-white hydrated oxide of copper is nearly redissolved.

rare, the other of extremely rare occurrence. The sulphuret of antimony is orange-coloured. There is a strong presumption, therefore, in favour of arsenic, which may be converted into certainty by collecting and examining the precipitate, or by applying the ammonio-nitrate of silver and the ammonio-sulphate of copper to other portions of the same liquid.

The precipitated sulphide of arsenic having been allowed to subside, is to be carefully collected, washed, and dried, and submitted to a process of reduction similar to that already described when speaking of arsenious acid; and differing only in the substitution for charcoal of a flux containing an alkali. That usually employed is the *black flux* formed by incinerating a mixture of one part of nitrate of potash with two of the bitartrate. But incinerated acetate of soda (as recommended by Dr. Taylor) is to be preferred; or a mixture of one part of cyanide of potassium with three parts of carbonate of soda, previously well dried. If this last flux is used it should be in the proportion of 1 of the sulphide to 12 of the flux. The metallic crust obtained by this process of reduction, like that obtained from arsenious acid by charcoal, is a mixed crust, consisting of metallic arsenic, arsenious acid, and undecomposed sulphide.

In dealing with minute quantities of the sulphide, the method of reduction by the capillary tube (fig. 34, p. 378) should be employed, followed, if the quantity of the precipitate is sufficient, by the method described at p. 372 (fig. 17).

The precipitated sulphide of arsenic is readily distinguished from the sulphides of cadmium and tin, which it resembles in colour. The sulphide of arsenic is not precipitated by sulphide of ammonium till the ammonia has been expelled or neutralized by an acid; but the sulphides of cadmium and tin are thrown down immediately. The sulphide of arsenic is very soluble in ammonia, while those of cadmium and tin are insoluble in it. The sulphide of arsenic yields a distinct metallic sublimate, while the sulphide of tin yields none, and the sulphide of cadmium gives a metallic sublimate with the characteristic properties described at p. 376.

When the liquid from which the sulphide is precipitated is not wholly free from colour or from organic matter, the precipitate should be dissolved in ammonia, and again thrown down by the addition of hydrochloric acid.

The gaseous test, then, applied with simple precautions, and followed by the reduction of the metal from the sulphide, gives certain evidence of arsenic. It is unnecessary, though for medico-legal purposes desirable, to convert the sublimed metal into crystals of arsenious acid to dissolve the crystals, and to apply the liquid tests to the solution.

Marsh's Test.—This ingenious and valuable test was proposed by Mr. Marsh, of Woolwich, about the year 1835. He employed two forms of apparatus; the one (fig. 37) consisted of a tube bent in the

shape of the letter J, the long leg being twice the length of the shorter one, and open, and the latter furnished with a stop-cock terminated by a nozzle with a minute bore. Hydrogen was generated in this apparatus by pure zinc and dilute sulphuric acid, to which a portion of the liquid containing arsenic was added. When the arseniuretted hydrogen had filled the smaller leg of the tube the stop-cock was opened, and the jet of gas inflamed. On holding over the flame a piece of glass or porcelain, a distinct metallic ring was deposited upon it. For larger quantities of liquid Mr. Marsh made use of the apparatus depicted in fig. 38.* Many alterations and modifications of Marsh's apparatus have been since suggested, which it is unnecessary to describe. The subjoined engraving

Fig. 37.

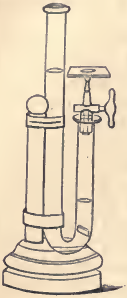


Fig. 38.

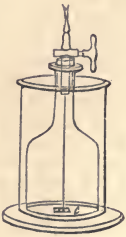
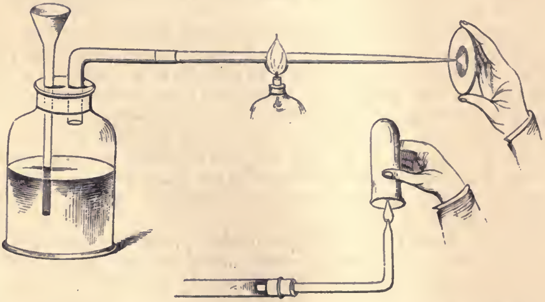


Fig. 39.



represents the most convenient form. The apparatus consists of a wide-mouthed bottle with a closely fitting cork, pierced for two tubes, of which the one, furnished with a funnel, dips beneath the liquid, and the other bent nearly at right angles, but sloping slightly towards the bottle, descends but a short distance into the vessel. This tube is furnished with a cork for the reception of a detached horizontal tube

* For an account of the apparatus employed by Mr. Marsh, and the results which he obtained, refer to the 'Transactions of the Society of Arts,' vol. li., Session 1835-6.

of glass free from lead, and drawn out at its extremity into a point with a small aperture.

In this apparatus hydrogen is generated by pure zinc and dilute sulphuric acid, and the action is continued till the atmospheric air is completely expelled, and all risk of an explosion is thereby avoided. The flame of a spirit-lamp is then to be steadily applied for ten or fifteen minutes consecutively to the horizontal tube. If there is no deposit on the sides of the tube, we conclude that the zinc and sulphuric acid do not themselves contain arsenic. Having convinced ourselves of the purity of these substances, we pour into the funnelled tube a portion of the liquid supposed to contain arsenious acid, and immediately reapply the spirit-lamp to the horizontal tube. If the liquid contain arsenious acid, a metallic deposit will take place on the tube at the distance of half an inch or more from the part to which the flame is applied. The horizontal tube should be at least five or six inches in length, so that we may obtain two such crusts at least. Having procured these, we may inflame the hydrogen as it issues from the end of the horizontal tube, and obtain one or two deposits on slips of porcelain, and others on discs of crown glass. A very minute quantity of arsenic will suffice for both these purposes. We may then continue to apply the flame of the spirit-lamp to the horizontal tube, until the absence of stain from a fragment of glass held before the jet proves that the metal is exhausted. The spots thus obtained consist either of arsenic or of antimony.

The evidence afforded by the metallic stains thus obtained may be confirmed by bending the horizontal tube at right angles and holding a wide test-tube over the flame. The tube will be coated with arsenious acid resulting from the oxidation of the metal. The contents of the tube may be dissolved in a small quantity of distilled water and the solution proved to contain arsenious acid by the liquid tests.

The round spots or stains on the flat surface of porcelain have the following distinctive properties:—

a. The arsenical stain has every variety of metallic lustre from that of copper to that of steel, but it never wears the sooty appearance which belongs to the crusts of antimony. *b*. The arsenical stain is much more readily dissipated by the heat of the spirit-lamp flame, and gives out the garlic odour.* *c*. The two stains are characteristically affected by several liquid and gaseous reagents, from which I select three, the first two as tests by simple solution, the last as a test by solution followed by a characteristic coloured deposit. Of these three tests the

* As this is a characteristic property of the arsenical stain, it may be applied in practice as follows:—Procure a crust of arsenic and one of antimony on the ends of two oblong porcelain slabs. Obtain two stains at the other ends of the slabs from the liquid under examination; apply the flame of the spirit-lamp steadily to the centre of the porcelain between the two stains. If there is an arsenic stain at one end, and an antimony stain at the other, the first will soon contract under the heat, and ultimately disappear, before the other shows any signs of being affected by the heat.

first was originally suggested by Bischoff, the second is now proposed for the first time, and the third was suggested by the author in the 'Medical Times,' July, 1847.

1. The arsenical stain is rapidly dissolved by a solution of the chloride of lime (bleaching liquid) which does not affect the antimonial stain. 2. The antimonial stain is less speedily, but at length completely dissolved by a solution of the proto-chloride or perchloride of tin, which does not dissolve the arsenical stain. 3. The antimonial stain is rapidly dissolved by the sulphide of ammonium; the arsenical stain slowly and imperfectly. The solution of the antimonial stain, when dry, leaves an orange-coloured spot of sulphide of antimony, while the imperfectly-dissolved arsenical stain, when dry, presents a light lemon-yellow spot of sulphide of arsenic mixed with portions of undissolved metal.

Several other modes of distinguishing these stains have been proposed, such as the vapours of iodine and phosphorus, the tincture of iodine, and nitro-muriatic acid followed by a solution of nitrate of silver to the dried spot; but the three tests of chloride of lime, protochloride of tin, and sulphide of ammonium are sufficient for every practical purpose. The last-named test has the peculiar advantage of leaving behind highly characteristic and permanent appearances.

The larger and thicker stains of arsenic may also be readily identified by the microscope. Globules of metallic arsenic may be seen by the higher powers on the discs of glass; or they may be transferred from the slab of porcelain to a disc of glass by the method described at p. 378, and illustrated in fig. 33. The disc of glass, examined under the higher powers of the microscope, will be found to be covered with octahedral crystals; or, if the cell is very shallow, with globules of the metal.

The stains of antimony and arsenic in the tube also present some remarkable differences. The antimony is deposited close to the point of the tube to which the heat is applied, and on both sides of the flame; the arsenic at some distance from it. This difference is shown in the annexed woodcuts, of which A represents the arsenial stain and B the

Fig. 40.
A

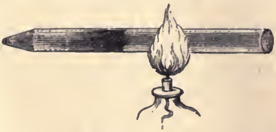
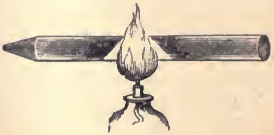


Fig. 41.
B



antimonial stain. The antimony volatilizes very slowly, the arsenic rapidly, on the application of heat; the arsenic has often a nut-brown colour nearly resembling that of copper, the antimony more nearly resembles tin. Of these properties the first and second are highly cha-

racteristic, but the colour of the crusts is less constant; for though antimony rarely presents the distinct copper colour of arsenic, nor arsenic the tin-like lustre which belongs to most crusts of antimony, it is possible to obtain crusts of antimony and arsenic very closely resembling each other in colour, though not in shape or position. The effect of heat is quite decisive; for while the crust of antimony moves slowly under the heat of the spirit lamp, and undergoes no remarkable change, the crust of arsenic is easily dissipated, and readily converted into characteristic crystals of arsenious acid. The crusts of arsenic and antimony may also be readily distinguished by detaching the horizontal tube, and transmitting a stream of dry sulphuretted hydrogen gas through it, at the same time chasing the metal, by the heat of the spirit lamp, in a direction opposite to the stream of gas. The antimonial crust is made to change its place slowly and with difficulty, and gradually assumes, but only in part, the characteristic orange hue of the sulphide of antimony; while the stain of arsenic is readily driven from point to point as a light lemon-yellow sulphide, forming a distinct crust, which disappears with the continued application of heat.

Some precautions are necessary in the use of Marsh's test. To avoid the risk of explosion, the gas should be generated freely at first, but less briskly at the time of adding the suspected liquid; for the smallest addition of another metal occasions a violent extrication of gas. The first violent action having subsided, the jet should be lighted to ascertain that the risk of explosion has passed; and the absence of arsenic (in other words the purity of the zinc and sulphuric acid) ascertained by repeatedly applying a clean surface of porcelain to the jet, as well as by steadily applying the flame of the spirit lamp to the horizontal tube for several minutes. If there is no stain on the porcelain or on the tube, the zinc and sulphuric acid may be assumed to be free from arsenic; and the suspected liquid may be added drop by drop, the flame of the spirit lamp being kept all the time steadily applied to the horizontal tube. A few stains should also be obtained on porcelain and on glass. If there should happen to be much froth, a small quantity of spirits of wine may be poured into the funnelled tube. By proceeding in this manner all risk is avoided, and all objections are obviated.

Reinsch's Test.—This test consists in adding to the liquid containing arsenic, a few drops of pure hydrochloric acid, introducing it into a test tube with a narrow short slip of bright copper, and heating the liquid to the boiling point. If the slip of copper is speedily tarnished by the liquid, other slips may be introduced one by one, until the copper retains its colour. The slips of copper are then to be removed from the liquid, washed in distilled water, and dried at a low temperature. The metal arsenic will be found to form an iron-grey coating, adherent if in small quantity, but readily separating if more abundant. A single slip of copper if thickly coated (or several slips if merely stained) is then to be introduced into the capillary reduction-tube (fig. 34), with the precautions described at p. 378. Arsenious

acid in the form of minute octahedral crystals, readily identified under the microscope, will be found to line the capillary portion of the tube. If characteristic results are obtained by this process, other slips may be similarly treated in the simple mode described at p. 372, and illustrated in fig. 17, or by the method figured and described in fig. 33, p. 378. The crystals of arsenious acid, being thus obtained on a flat surface, are in a state very favourable for microscopic examination.

By any of these three methods satisfactory results should be obtained with the thousandth of a grain of metallic arsenic, and in skilful and practised hands with the five-thousandth of a grain.*

Certain precautions must be taken in employing this test. As the hydrochloric acid may itself contain arsenic, its purity must be ascertained by diluting with distilled water, and boiling in it a strip of clean pure copper. And as it is now well ascertained that almost all specimens of copper, and even many specimens thrown down by the electrotype process, contain arsenic, its purity must be previously ascertained. If the copper, when boiled in the dilute hydrochloric acid, is untarnished, the acid may be considered pure; and if the copper itself, when boiled in the acid liquor supposed to contain arsenic, is not dissolved, and does not impart a green colour to the liquid, the copper may be used with safety. It is only in those cases where the liquid which is being tested dissolves the copper, that the impurity of the metal can interfere with the result. In order, however, to guard against both actual fallacies and speculative objections, a copper of ascertained purity should be used.†

The process of reduction which constitutes the second part of the test is rendered necessary by the fact, that other metals as well as arsenic, when treated in the same way, also yield metallic deposits: solutions containing mercury and silver without boiling, and those containing antimony, bismuth, tin, and lead, on applying heat. Alkaline sulphurets also tarnish the metal.

As the appearances presented by these metallic deposits, though different, are not so different as to serve for tests, the process of reduction is absolutely necessary. The formation of octahedral crystals effectually distinguishes the arsenical crust from all others; and as these crystals may be certainly obtained from less than a thousandth of a grain of the metal, and readily identified by the higher powers of the microscope ($\frac{1}{4}$ or $\frac{1}{8}$), no other distinction can be required.

As it is very important that these and similar statements respecting the detection of minute quantities of arsenic, or of other poisons, should not be discredited, a short digression on the divisibility of matter may

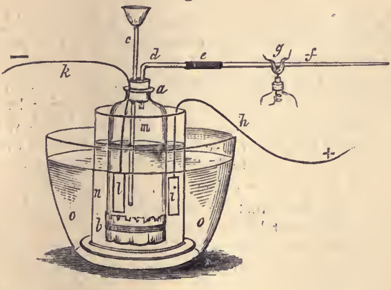
* To obtain these small quantities for purposes of experiment, prepare a thousand small slips of copper, and boil them in an ounce of distilled water acidulated with hydrochloric acid, and holding in solution $1\frac{1}{3}$ grain $As\,O_3$. The slips of copper will be distinctly coated with metal, and, if equally coated, each would carry $\frac{1}{1000}$ grain. Experiment successively with a slip, and with fractional parts of a slip, up to a fifth, or less.

† Consult a paper by Dr. A. Taylor on 'Facts and Fallacies connected with the research for Arsenic and Antimony, &c.,' in 'Guy's Hospital Reports,' 1860.

be permitted. Some misapprehension certainly exists on this subject in consequence of the bulk of matter represented by a grain being undervalued. The best way to correct this misconception appeared to be the counting out of the number of distinct particles of common objects visible by the naked eye. I have caused this to be done in the case of certain small seeds, and have found that the seeds of digitalis number 1126 to the grain, and those of lobelia inflata 3176, while the fern seeds of the shops can be counted to the number of 50,900 to the grain. When, therefore, we speak of the ready identification of the thousandth of a grain of arsenic, and the possible recognition of the five thousandth of a grain, we are still speaking of visible particles. When, again, we speak of metallic crusts obtained by Marsh's apparatus, from the half-millionth or millionth of a grain of arsenic, or of a thousand fragments of copper thickly coated by a grain of arsenic according to Reinsch's method, it is only necessary to revert to the fact, that a single grain of gold can be mechanically divided into 490,000 visible pieces; and into the almost incredible number of 4,900,000,000 fragments visible by the microscope. (See Miller's 'Elements of Chemistry,' Part I. p. 4.)

Galvanic Test.—My colleague, Professor C. L. Bloxam, has lately advocated the method of electrolysis as the best and least objectionable means of generating arseniuretted hydrogen and procuring crusts of metallic arsenic. He first made use of a simple modification of the J-tube figured at p. 382, but afterwards preferred an apparatus of the form shown in the annexed engraving, in which *m* is a two-ounce narrow-mouthed bottle, the bottom of which is replaced by a piece

Fig. 42.



of vegetable parchment *b*, secured by thin platinum wire. The cork *a*, carries a funnelled-tube *c*, a small tube *d*, bent at right angles, and connected by a caoutchouc tube *e*, with a drawn-out reduction-tube *f*; and it is pierced by a platinum wire *k*, suspending a plate of platinum-foil *l*. The wire is connected with the negative pole of a galvanic battery. This bottle is placed in a glass *n*, a little larger than

itself, and into which the positive plate *i*, attached to the wire *h*, of the battery is introduced. The apparatus is placed in a larger vessel, *o o*, filled with cold water. An ounce of dilute sulphuric acid (1 acid to 3 water) is then introduced into the bottle, the poles are connected with the battery, and hydrogen gas is generated till all fear of an explosion ceases. The shoulder of the reduction-tube at *g*, is then to be heated to redness during fifteen minutes, to ascertain the purity of the sulphuric acid. The liquid to be tested is then introduced through the funnelled tube *c*. Frothing is prevented by adding a drachm of alcohol. The metal arsenic is then reduced in the horizontal tube at *g*, as in the modern form of Marsh's apparatus.

This method has the advantage of superseding the use of zinc in generating the arseniuretted hydrogen, and thus excluding one possible source of fallacy; and it is very delicate. It was successively applied in a series of experiments with quantities of arsenious acid varying from the $\frac{1}{100}$ to the $\frac{1}{1000}$ grain, a characteristic arsenical mirror, a shining ring of crystals of arsenious acid, and the alliaceous odour being obtained in each instance. This method is applicable to the detection of antimony, mercury, and of other metals.*

3. *Arsenious Acid in Organic Liquids.*

As arsenious acid is very insoluble in water, and still more so in liquids containing organic matter, the poison may sometimes be obtained in a solid form by diluting with distilled water, and allowing the powder to subside. The poison may also be found adhering to the mucous coat of the stomach, from which it may be detached. The solid arsenious acid so obtained may be treated in the manner described at p. 371.

If there is no solid arsenious acid in the organic liquid, the poison may still be diffused through it, or dissolved in it; in which case the liquid must be rendered slightly alkaline by liquor potassæ, and then carefully evaporated to dryness over a water-bath. By this means a large portion of the organic matter is coagulated, so that by boiling the residue in distilled water, a liquid is obtained which will pass the filter; and may be treated as arsenious acid in solution by any of the methods described at p. 380. This method of procedure is only available where time is no object. In all other cases the process presently to be described must be employed. The solid matters that remain on the filter must be preserved, so that if we fail to procure evidence of arsenic from the filtered liquid, this solid residue may be treated by the methods now to be described as applicable to the solids and fluids of the body.

* On the application of Electrolysis to the detection of the poisonous metals in mixtures containing organic matters. ('Quarterly Journal of the Chemical Society,' 1860.) For information concerning the fallacies which may attach to the processes of Marsh and Reinsch, consult this valuable paper; also a paper by Wm. Odling, M.B., on some failures of Marsh's process for the detection of arsenic, and Dr. Taylor's 'Facts and Fallacies,' &c., in the 'Guy's Hospital Reports,' 1860.

4. *Arsenious Acid in the Solids or Fluids of the Body.*

As there are cases of poisoning by arsenic, in which the poison is entirely expelled during life, so that no trace of it can be discovered in the stomach after death, it is most important to be able to detect the poison in the fluids or solids to which it has been conveyed by absorption.

All the methods which have been at different times proposed for effecting this object consist of three essential parts:—The destruction of the animal matter so as to obtain a liquid which will pass the filter; the reduction of the poison to the metallic state by Reinsch's or Marsh's method, or by the method of electrolysis advocated by Professor Bloxam; and the complete identification of the metal.

For the destruction of the animal matter four principal methods have been proposed—one by nitrate of potash; a second by nitric acid; a third by sulphuric acid; and a fourth by hydrochloric acid. The last of these methods is recommended by its simplicity, as well as by the fact that the acid employed is the same that is used in Reinsch's test.

In the following process, proposed by Fresenius and recommended by Professor Bloxam, hydrochloric acid is employed, with the addition of chlorate of potash, followed by the bisulphite of soda, which has the great advantage of bringing back the poison to the convenient and manageable form of arsenious acid.

If the organic matters are in a solid state, they must be reduced to a fine state of division and be brought to the consistence of thick gruel by mixture with water. If already in a liquid state, we proceed at once to digest them for an hour, in a porcelain dish over a water-bath with about half an ounce of hydrochloric acid, adding powdered chlorate of potash occasionally until the organic matters are disintegrated. The resulting liquid is then to be filtered off, and evaporated over the water-bath to about an ounce. The coloured fluid thus obtained is poured into a flask, and a few drops of a strong solution of bisulphite of soda are added to it till it smells strongly of sulphurous acid. The flask is then heated in a water-bath, until this odour ceases. The resulting solution, mixed with at least an equal bulk of water, may be examined for arsenic by any or all of the methods already described at p. 380.

Quantitative Analysis.—The quantity of arsenious acid contained in a substance submitted to analysis is best determined by the use of the pure sulphide of arsenic obtained from a measured portion of the filtered liquid: 100 grains of the sulphide very nearly correspond to 80 grains of arsenious acid.

When the body of a person supposed to have been poisoned by arsenious acid, or by other preparations of arsenic, is disinterred for the purpose of analysis, and the poison is detected in the stomach, in the solid textures, or in the fluids of the body, it is sometimes alleged that the arsenic contained in the surrounding soil was dissolved in water and

conveyed into the body. To meet this allegation it is deemed necessary to analyze a portion of the soil. One or two pounds of the soil are first treated with boiling water, and the filtered liquid reduced by evaporation to a convenient quantity is tested by Reinsch's process. If this gives no indication of the presence of arsenic, the soil is to be treated with one part of hydrochloric acid to ten of water. The lime and iron dissolved by this means are to be thrown down by adding bicarbonate of potash in excess, and the resulting liquid filtered and reduced as before, is to be examined by Reinsch's test.

The following facts bearing on the value to be attached to the detection of arsenic in the dead body require to be borne in mind :—

a. Arsenic may be detected in the dead body after such long intervals of time as seven and ten years. Arsenious acid, which is usually found attached to the coats of the recent stomach as a white powder or paste, is converted into the yellow sulphide by the sulphuretted hydrogen given out in the process of putrefaction.

b. Orfila affirmed that arsenic is a natural constituent of the body itself; and that it may be discovered both in the fleshy parts of the body and in the bones. But subsequent researches of himself and others have shown that there was in his first experiments some source of fallacy.

c. Arsenic when contained in the soil of cemeteries is generally, if not always, in an insoluble form, in combination with iron or lime.

d. Preparations of arsenic, whether taken in single large doses, or in repeated small ones, are absorbed into the blood, and may be found in the textures and secretions; and they are only slowly eliminated from the body. The limit usually stated for the complete elimination of arsenic from the human body is three weeks; but it has been extended to a month by M. Bonjean. (See Ranking's retrospect, vol. iii., 'Report on Forensic Medicine.')

e. Preparations of arsenic have a preservative effect on dead animal matter.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—In most cases the symptoms set in within an hour of the swallowing of the poison, with burning pain at the pit of the stomach increased by pressure, nausea, and vomiting renewed by the act of swallowing. The pain soon becomes more diffuse, and there is swelling and tenderness of the belly, with diarrhœa, tenesmus, and dysuria. After the setting in of vomiting, if not previously, there is a sense of constriction in the throat, with intense thirst, inflammation and smarting of the eyes, headache, violent beating of the heart, frequent pulse, quick catching respiration, extreme restlessness, great debility, cramps in the legs, and convulsive twitchings in the extremities. In the majority of cases the mind is intact. When the poison proves rapidly fatal, death commonly takes place by collapse, or by coma; in more chronic cases, the patient dies exhausted by the violence of the irritative fever, or after a long train of nervous

symptoms terminated by convulsions. Patients who recover are either restored to perfect health, or they suffer from indigestion, from prolonged weakness or palsy of the limbs, or from epileptic fits.

But cases of poisoning by arsenic present not only the greatest possible variety in the character, combination, and severity of the symptoms, but exceptions to general rules, and anomalies of the most perplexing kind.

In one considerable class of cases, the symptoms are those just detailed, but in a more aggravated form. The vomiting is incessant, the pain in the pit of the stomach most acute, and increased by the slightest pressure; the mouth, tongue, and throat are red, hot, and swollen; the eyes bloodshot; the countenance flushed; the thirst excessive; the diarrhœa profuse, and attended with tenesmus and discharges of blood; the belly acutely painful and tender, and much swollen; the urine is suppressed or passed with pain and difficulty; the pulse is full, quick, and frequent; and the respiration laborious and painful; there is a sense of fulness and oppression at the heart with violent palpitation; there is intense headache, with giddiness, incessant restlessness, and severe cramps in the legs and arms, followed, if life is prolonged, by convulsions, tetanic spasms, epileptic fits, delirium, coma—a group of nervous symptoms varying with each case, and terminating in various ways, and at various intervals, in recovery or death.

In a second class of cases the symptoms are those of collapse. There is little or no pain, vomiting, or diarrhœa, a cold and clammy skin, extreme prostration of strength, the pulse very frequent and almost imperceptible, or so low as thirty or forty beats in the minute. The mind, as in most cases of poisoning by arsenic, is unimpaired, but there is some approach to coma, slight cramps or convulsions, and death without reaction. Sometimes this state of collapse is accompanied by constant vomiting and profuse purging. In this class of cases, death often takes place in four or five hours, and it is rarely delayed beyond twenty hours.

In a third class of cases, the patient falls into a profound sleep, deepening into coma, and dies in a few hours without rallying. Such a case is recorded by Mr. T. Wright, of Dublin. Death took place in four hours, and followed upon sound sleep; and after death there was no trace of inflammation of the mucous membrane even in the spots covered with arsenic. ('Lancet,' vol. xii., p. 194.)

In a fourth class of cases, the symptoms so closely resemble those of a common attack of English cholera, as to have averted suspicion from the minds of intelligent and well-informed physicians. Such was the case of the Duke of Praslin.

All these varieties of cases develop themselves under large and small doses of the poison; and they are not to be accounted for by the form or vehicle in which it is administered. The same dose administered in the same way may give rise to prolonged vomiting and purging in one

man, to collapse in a second, to coma in a third, to violent irritative fever and severe nervous symptoms in a fourth; and these leading forms may even run into, and be blended with, each other.

Though these varieties do not admit of complete explanation they become more intelligible when we reflect that the poison is an irritant by contact with the alimentary canal, and, as such, gives rise to all the symptoms, local and remote, which follow on such irritation,—pain and tenderness, vomiting and purging, cramps and spasms; that it is absorbed into, and circulated with, the blood, developing in this manner its specific symptoms on the whole course of the alimentary mucous tract, and not only reinforcing the direct effect of the poison in causing pain and tenderness, vomiting and purging, but superadding redness and smarting of the conjunctiva, intense thirst, palpitation and rapid pulse; that it affects the nervous system both by the direct violence of its action on the parts with which it comes in contact, and by being circulated with the blood through the nervous centres, hence delirium, convulsions, tetanic spasms, epileptic fits, extreme weakness, paralysis; and that, lastly, it is in course of elimination from the system through the secretions of the liver, kidneys, and skin, giving rise in one person to jaundice, in another to dysuria, and even suppression of urine with its natural consequence, blood tainted with urea, and coma as a sequence, and in a third to painful cutaneous eruptions. Administered in large doses, or to feeble persons, the first shock to the system might prove fatal, as in drinking cold water or in blows on the stomach.

The great importance which attaches to the subject of poisoning by arsenic, and the very variable character and grouping of the symptoms in different cases, renders a more detailed account of symptoms and of combinations of symptoms desirable. The following summary is based chiefly on a careful analysis of a group of 25 cases.

Alimentary Canal.—*Vomiting* was stated to be present in 23 cases, but in one case not till artificially induced. In a few cases, this, in common with every other marked symptom, has been wholly absent. The *vomited matters* consisted, in 3 cases, of blood; in 2, of mucus tinged with blood; in 1, of mucus only; in 1, of water containing arsenic; in 1, of bile, and in 1, of bile and fæces. The vomited matters are sometimes described as yellow or brown. *Diarrhœa* was present in 11 cases, but absent in 4, out of 15 in which the symptom is mentioned; in 7 cases it was excessive. The *matters passed by stool* consisted, in 3 cases of blood, and in 2 of a material closely resembling green paint. *Pain:* Of 20 cases in which this symptom is mentioned, it was present in 19, and altogether absent in 1; in 2 instances it subsided after a short time, and it is stated not to have been increased by pressure in 2 instances. The *tongue and throat* are described as sore, constricted, hot, painful, and tense, in 9 cases. *Thirst:* Of 17 cases in which this symptom is mentioned, it was present in 15, and absent in 2; in 13 it is described as intense. The *countenance* was flushed

and swollen, in 7 cases; pale and anxious in 5: the facies hippocratica present in one. The *eyes* were inflamed, swollen, or smarting in 7 cases. The *skin* hot and dry in 6 cases; covered with cold perspiration in 4; profuse perspiration with petechiæ in 3; universal desquamation in 1; covered with an eczematous eruption in 1. *Headache* in 9 cases, absent in 1; described as intense in 4. Violent *palpitation* in 2 cases. *Pulse* generally very frequent, but of variable character, ranging from 90 to 140, or more; in one case 30 to 49. Jaundice, suppression of urine, strangury, and salivation must be added to this list of symptoms.

Some of the leading symptoms and groups of symptoms are deserving of special notice.

Nervous Symptoms.—These are not only of great severity in many acute cases, but they have been of very long continuance. Thus, Mr. Gadsden, one of the victims of Eliza Fenning, was seized with epilepsy on the first day; had four attacks on the second day, then a fit every evening at the same hour, for fourteen successive evenings; then an interval of seven or eight days, followed by another relapse, and that by another interval of three weeks; at the end of three months the fit still recurred every twelve hours, or three or four times in two days; and he continued, even after the lapse of two years, to be subject to frequent attacks. In the case of Helen Mitchell, there was extreme debility of the limbs for three months.

A careful analysis of 25 cases of poisoning by arsenious acid yielded the following results in respect of this class of symptoms. There was extreme *restlessness* in 5 cases; extreme *debility* in 10 cases; *coma* in 3 cases; *delirium* in 3. The *mind* was stated to be unimpaired in 6 cases; there were *cramps* in the legs in 9 cases, in 4 extending to the arms; *convulsions* in 6 cases; *paralysis* of tongue and gullet in 3 cases; *tetanus* in 2 cases; *chorea* in 1; *hysteria* in 1; *epilepsy* in 2 cases. Tetanus, coma, and delirium successively in 2 cases. *Death* took place in 3 cases in the midst of convulsions, and in one after a horrible fit of convulsive laughter followed by rigid spasm of the whole body.

Locked jaw has been observed among the early symptoms—in one case so early as three quarters of an hour. (Orfila.)*

Post-mortem Appearances.—The stomach is the seat of acute in-

* The reader is referred to the following cases:—the cases of the Messrs. Turner, and Mr. Gadsden, poisoned by Eliza Fenning, in Mr. Marshall's Remarks on Arsenic; those of the Mitchells, reported by Mr. Alexander Murray, in the Edin. Med. and Surg. Journal, vol. xviii. p. 167, and three cases given by Mr. Alexander McLeod, in the same Journal, vol. xv. p. 553. These cases afford some of the best illustrations of the nervous symptoms which follow poisoning by arsenic. Also Ed. Med. and Surg. Journal, v. 389; liv. 106, 262; lvi. 295; lix. 250. Lancet, July 21, 1827; Aug. 15, 1829; Oct. 31, 1829, vii. 254; Oct. 6, 1838; Nov. 3, 1838; and Nov. 24, 1838. Medical Gazette, v. 411; ix. 895; xiv. 62; xv. 828; xix. 238; xx. 309. London Medical Review, iv. 188; xix. 288. Guy's Hospital Reports, No. iv. 68; and subsequent volumes.

flammation, sometimes spreading over the entire surface, sometimes confined to the prominent folds of the membrane, sometimes existing in well-defined patches. Sometimes, in lieu of the bright tint of inflammation the mucous membrane has the deep hue of congestion. The most common and characteristic appearance is that of one or more patches from the size of a shilling to that of a crown piece, consisting of a tough white or yellowish paste of arsenious acid, mixed with coagulable lymph, firmly adhering to the inflamed mucous membrane, and forming so many centres of intense inflammation. White spots of arsenious acid are also often found between the rugæ. Ulceration is comparatively rare, and perforation still less common. Gangrene also is a rare occurrence; but the dark swollen appearance produced by extravasation of blood beneath the mucous membrane is often met with. The stomach usually contains a brown grumous matter, which is occasionally tinged with blood; but sometimes the colour is yellow from the partial conversion of the poison into sulphide; and the mucous coat has been found smeared as with yellow paint. The inflammation generally extends to the duodenum and commencement of the other small intestines, and occasionally affects the whole length of the intestinal canal, being most conspicuous in the lower bowel. The œsophagus, also, is sometimes the seat of inflammation, and in rare instances the mouth, tongue, fauces, and windpipe have been involved in the inflammatory action. The peritoneal covering of the stomach or of the entire abdomen is sometimes found in a state of inflammation, and the intestinal glands are swollen.

Among occasional post-mortem appearances may be mentioned, inflammation of the bladder, livid spots on the skin, and congestion of the brain and serous effusion.

The most remarkable post-mortem appearance, however, is the absence from the mucous membrane of the stomach of all traces of inflammation, and of every other characteristic change. This anomaly is not due to the death having taken place before there was time for inflammation to be set up; for well-marked inflammatory appearances have been present in the most rapidly fatal cases.

It happens fortunately for the ends of justice that arsenic not only preserves the stomach with which it is in contact when surrounding parts are in a state of advanced decay, but that even the characteristic appearances of inflammation are present after several months of interment.

Fatal Dose.—The smallest fatal dose of arsenious acid on record is *two grains and a half*. It was contained in two ounces of fly-water, and proved fatal to a strong healthy girl, nineteen years of age, in thirty-six hours (Dr. Letheby). Much smaller quantities have given rise to alarming symptoms. On the other hand, recovery has taken place from doses of half an ounce, an ounce, and even an ounce and a half. The larger doses of the poison are often taken on a full stomach,

in substance, or in powder, and are promptly rejected with the food, or carried away by the brisk action of the bowels.

Fatal Period.—The poison has proved fatal in as short a period as *two hours*, in three or four instances (one by Mr. Foster, of Huntingdon, and one by Mr. Macaulay, of Leicester).

On the other hand cases may prove fatal after three, four, five, six, or seven days, or even as late as the second or third week. The average duration of fatal cases is 20 hours, and that of all the cases which terminate within 24 hours is less than 7 hours. As many as 85 in the 100 die within 24 hours. More than half the cases terminate within 6 hours, two-thirds within 8 hours, and more than three-fourths within 12 hours.*

Fatality.—Fatal cases and cases of recovery are nearly equally divided. The first class are to the second as 52 to 48.

Proportion of Suicidal, Homicidal, and Accidental Cases.—In 100 cases, about 46 are suicidal, 37 homicidal, and 8 accidental. This statement is based on an analysis of 92 cases. The cases of suicide were equally divided between men and women.

Commencement of Symptoms.—In some instances the symptoms have come on in ten minutes after taking the poison. They have even been described as setting in immediately. But in other instances they have not made their appearance for several hours, and have been even delayed till ten hours. It is natural to suppose that sleep would have the effect of delaying the operation of the poison.

Treatment.—As arsenious acid itself is a powerful emetic, it sometimes excites such effectual vomiting that it is completely rejected from the stomach. This is most likely to happen when it is swallowed with, or soon after a meal. In other cases on the exhibition of an emetic, or the abundant use of diluents, the contents of the stomach are rejected, and with them the poison. When, on the other hand, the poison is swallowed on an empty stomach, it attaches itself to the mucous coat, excites violent inflammation, and the formation of a tenacious secretion, by which it is glued to its surface and protected from the action both of emetics and antidotes. In the first class of cases recovery is often attributed to some substance which is thought to possess the virtues of an antidote. Arsenic, also, by its purgative action sometimes occasions so free an evacuation of the bowels that the poison is partly carried off by this channel.

The first step in the treatment consists in removing the poison as promptly as possible from the stomach. If the stomach-pump is at hand it should be used without delay. If not, and the poison itself is

* Out of 41 cases which proved fatal within a day, 3 were fatal in 2 hours; 1 in 2 hours and a half; 1 in 3 hours; 2 in 3 hours and a half; 8 in 4 hours; 6 in 5 hours; 6 in 6 hours; 2 in 6 hours and a half; 1 in 7 hours; 2 in 8 hours; 3 in 9 hours; 2 in 12 hours; 1 in 15 hours; 1 in 17 hours; 1 in 21 hours, and 1 in 24 hours. Of 7 which lasted more than one day, 1 was fatal in 36 hours; 2 in 48 hours; 1 in 3 days and a half; 1 in 4 days and a half; 1 in 6 days, and 1 in 7 days.

acting freely as an emetic, vomiting should be promoted by copious draughts of warm milk and water, and tickling of the throat with a feather. If the patient is not sick, emetics of ipecacuanha, mustard, or common salt, aided by similar copious draughts of warm milk and water should be given. When the stomach has been emptied by these means, milk, or milk beaten up with eggs, or a mixture of milk, lime water, and white of egg, should be given freely at short intervals.

The rest of the treatment will be determined by the symptoms which happen to be most urgent. If the inflammatory symptoms run high blood may be taken from the arm, or by leeches from the pit of the stomach. When coma threatens, blood may also be removed with advantage. The state of collapse must be met by stimulants, and the nervous symptoms by anodynes. Tetanic spasms would be best relieved by chloroform. The intense thirst may be satiated with small quantities of acid water; the tenesmus and dysuria by injections of gruel containing laudanum; the diarrhœa, if ineffectual and painful, by castor oil mixed with milk. Antimony ought not to be given as an emetic, inasmuch as the resemblance of the crusts of antimony to those of arsenic gives rise to an objection to the chemical evidence. Sulphate of zinc, and antidotes containing iron ought perhaps also to be avoided, lest it should be alleged that arsenic detected in the stomach existed in them as an impurity.

Antidotes.—When arsenious acid has been given in solution, the hydrated sesquioxide of iron, the acetate of the sesquioxide, the hydrated persulphuret of iron, the hydrated oxide of magnesia, calcined magnesia, or animal charcoal freely administered (from 15 to 20 times the bulk of the poison), might be attended with some advantage. When the poison is taken in the solid form these reputed antidotes are quite useless. The hydrated oxide of magnesia precipitated from a strong solution of the sulphate by liq. potassæ, and well washed, is to be preferred, as being equally effectual with the others, and more free from objection should the patient succumb, and an analysis of the contents of the stomach be required.

In conducting the treatment of a case of poisoning by arsenious acid, or by other preparations of arsenic, it should be borne in mind that evidence of poisoning may be obtained by examining the urine, the serum from a blistered surface, or the blood drawn from the arm or by leeches, as well as from the matters vomited or passed from the bowels.

Arsenious acid has been introduced into the body in other ways than by the mouth. It has been inserted into the vagina, producing intense local inflammation, and the characteristic general symptoms of poisoning by arsenic. It has been applied to the skin in the form of a mixed powder and of ointment, with similar local and constitutional results; and it has been inhaled in the form of vapour. Severe indisposition has also been produced by the smoke of candles containing arsenic.

OTHER PREPARATIONS OF ARSENIC.

Arsenite of Potash.—This is the active principle of Fowler's solution, in which it is contained in the proportion of four grains to the ounce. It may be readily detected by any of the methods described for arsenious acid.

Arsenic Acid.—This acid, though a powerful poison, is of no medico-legal interest except inasmuch as it is formed in the course of some of the processes for detecting arsenious acid. It is a white deliquescent solid. It resembles arsenious acid in yielding a metallic sublimate when reduced with charcoal, and a metallic crust when treated by Marsh's or Reinsch's method. It also gives a yellow precipitate with sulphuretted hydrogen, on boiling. It differs from arsenious acid in being very soluble in water, in having a strong acid reaction, and in not being volatilized by the heat of a spirit-lamp. It is also precipitated a brown red by nitrate of silver, and by the ammonio-nitrate, while arsenious acid gives with the latter a yellow precipitate.

The combinations of arsenic acid are called arseniates, and have the same properties.

Arsenite of Copper. Scheele's Green.—This is a fine green powder, containing one part of arsenious acid to two parts of oxide of copper. It is readily identified by yielding distinct crystals of arsenious acid when heated, and a residue of oxide of copper; and it is soluble both in ammonia and in nitric acid.

Aceto-Arsenite of Copper. Emerald, mineral, Schweinfurth, Brunswick, or Vienna Green.—This also is a fine green powder largely used by paper-stainers, both for fancy-papers and for wall-papers, both alone to impart a full green colour, and mixed with oxide of zinc, with porcelain powder, or with whiting, to give more delicate tints of green. It has also been used to give a green colour to sweetmeats and confectionery, to wafers, to toys and cages, to cakes of water colour, to oil colours, to articles of dress, and to papers used as wrappers for fruits and sweetmeats.

Tests.—This poison is readily identified by giving off when heated strong fumes of acetic acid and crystals of arsenious acid, with a residue of oxide of copper.

Symptoms.—Those of the acute form of poisoning may be inferred from the case of a print-colourer admitted into King's College Hospital, June 1858. Death took place from an ounce of the aceto-arsenite of copper in seven hours, under symptoms belonging to the second class of cases of arsenical poisoning described at p. 391. He did not vomit till an emetic was administered, and diarrhœa did not form a prominent symptom. He was pale, excited, faint, and anxious, with a small feeble pulse, slight epigastric tenderness, intense thirst, profuse cold sweats, severe cramps in the calves of the legs and in the hands, with twitchings of the legs and arms. The patient never rallied, but died exhausted. The tongue was tinged green, and the matters re-

jected from the stomach and bowels were of the same colour The stomach-pump was used, and the hydrated sesquioxide of iron freely administered. The post-mortem appearances were a dirty green tongue, the stomach containing a large quantity of the antidote speckled with green, congestion of its mucous coat, and of that of the small intestines, deep chocolate colour of the folds of the stomach, and dots of extravasated blood over the surface, especially near the pylorus. The lungs were greatly congested; the brain and kidneys sound.

It may be stated generally that the symptoms, post-mortem appearances, and treatment of poisoning by the arsenite of copper and by the aceto-arsenite, are those of poisoning by arsenious acid.

Very severe symptoms of irritant poisoning have been induced by eating various substances coloured with arsenite of copper. They have been the usual symptoms of irritant poisoning. In one or two instances it has proved fatal. In two cases the symptom of jaundice showed itself as if the copper had proved active.

The symptoms of the chronic form of poisoning by the inhalation and swallowing of the powder detached from the walls of rooms have not been uniform. They have consisted of several of the following symptoms variously grouped. Nausea and loss of appetite, depression and weakness, colic, headache, dryness of the tongue and throat, thirst, cough, and watery and inflamed eyes.

Arsenite of copper mixed with warm size is largely used in making tinted papers and for paper-hangings, and is so laid on as to come into contact with the hands of the workmen. After working one or two days the men begin to suffer, and are soon obliged to abandon their employment. The first symptom produced is a papular rash, running on to pustulation, about the root of the nostrils; the back of the ears, the bends of the elbow, and the inside of the thighs suffer in order, and then the scrotum, which is often found sprinkled with superficial circular ulcers from the size of a split pea to that of a fourpenny piece, looking as if cut by a punch. Sometimes the fingers are inflamed, and the nails drop off. The pulse is sometimes increased in frequency, and occasionally the eyes smart and the epigastrium is tender. On abandoning the employment, the effects soon pass away; and they might certainly be avoided by scrupulous cleanliness and simple precautions to avoid contact with the poison. Dr. Prosper de Pietra Santa, in the 'Annales D'Hygiène,' October 1858, p. 339, gives a similar account of the effects of Schweinfurth green as used in Paris. Sea also an able paper by M. A. Chevallier in the same journal, July 1859.

The Arseniate and Binarseniate of Potash.—These are active poisons little used in this country. The arseniate is a white, deliquescent, and very soluble substance, and has the reactions of "arsenic acid." The binarseniate is known as "Macquir's neutral arsenical salt."

The Arseniate of Soda is used as a medicine in France. A grain

of the salt to an ounce of distilled water constitutes "Pearson's solution;" and paper soaked in a solution of one part of arseniate of soda and two of sugar in twenty parts of water, and dried, is in use for poisoning flies.

Sulphides of Arsenic.—Realgar, or red arsenic, and orpiment, or yellow arsenic, and King's yellow, which consists chiefly of orpiment, are largely used in tinting paper, and for other similar purposes. Both orpiment and King's yellow contain arsenious acid, often in considerable quantities. The yellow sulphide of arsenic is the precipitate thrown down by sulphuretted hydrogen gas from liquids containing arsenious or arsenic acid, and their compounds. It is also occasionally administered as a poison, and is sometimes found adhering to the coats of the stomach after death, having been formed, as already stated, by the union of arsenious acid with nascent sulphuretted hydrogen, given out during the process of decomposition. In organic mixtures the sulphides are detected by their characteristic colours. They are soluble in ammonia, and thrown down from the ammoniacal solution, in a state of sufficient purity, by muriatic acid.

The sulphides, when treated by black flux in the same manner that arsenious acid is treated by charcoal, yield metallic sublimates. (See p. 381.) When boiled with nitro-muriatic acid they are converted into arsenic and sulphuric acids. The symptoms of poisoning by the sulphides are those of poisoning by arsenious acid; and the post-mortem appearances are also the same, with the exception that the contents of the alimentary canal have a yellow colour, and that the mucous membrane is tinged of the same hue. The treatment is that of poisoning by arsenious acid.

Arseniuretted Hydrogen.—Several cases of poisoning by this gas, which is very rich in arsenic (each cubic inch containing little short of a grain of the metal), are on record. It has been more than once generated instead of hydrogen by sulphuric acid containing arsenic, and when inhaled has proved fatal. A very interesting series of cases affecting a whole family, and due to the inhalation of that gas evolved from decomposing arsenite of copper, have been related by Dr. Elliotson. The symptoms were nausea, vomiting, thirst, watering of the eyes, red and foul tongue; a rapid pulse, ranging from 120 to 160, and, after apparent recovery, pains in the limbs. The patients derived much advantage from blood-letting.

The poison, though inhaled by the lungs, seems to be eliminated by the kidney, in which organ it gives rise to severe irritation. In two instances cited by Christison ('On Poisons,' 4th Edition, p. 326) and in a third case by Vogel ('Brit. and For. Med. Chir. Review,' January 1854, p. 279) it gave rise to hæmaturia.

Compound cases of poisoning by arsenic are not of rare occurrence that by arsenic and opium jointly being the most frequent. The opium has the effect of masking the characteristic action of arsenic, so that the case resembles very closely the rare instances of arsenical poisoning, in which narcotic symptoms are very prominent. Such was

the character of a case of poisoning by arsenic and laudanum, which occurred some years since in King's College Hospital.

2. ANTIMONY AND ITS PREPARATIONS.

Until the last few years poisoning by antimony has been so rare an occurrence that the poison is not distinctly specified by the Registrar-General in the list of substances which proved fatal in the five years 1852-56. But since the trials of Palmer, Dove, McMullen, and Smethurst, of which the first three took place in the year 1856 and the last in 1859, the subject of poisoning by antimony, and especially by small repeated doses of tartar-emetic, has assumed great importance.

The preparations of antimony, which are important in a medico-legal point of view, are tartar-emetic and chloride of antimony. The precipitated sulphide of antimony is of interest from being developed in testing for the poison.

The *metal* antimony shares with arsenic the property of combining with nascent hydrogen, and of being deposited in the metallic form on burning the jet of gas, or heating the glass tube through which it is passing. It differs from arsenic in not being volatilized when in the mass by the heat of the spirit-lamp, and with difficulty when in the form of thin films. In common with arsenic, mercury, and several other metals, it is deposited in the metallic form on copper when its solutions are treated after the method of Reinsch. The metal antimony often contains a minute fraction of arsenic.

The precipitated sulphide formed by transmitting a stream of sulphuretted hydrogen through a solution of a salt of antimony, or by treating metallic stains of antimony with the sulphide of ammonium, is of a characteristic orange-red colour, and like the black prepared sulphuret yields metallic antimony when heated in a current of hydrogen gas.

Tartar Emetic (*Tartarised Antimony*, *Stibiated Tartar*, *Potassio-Tartrate of Antimony*).

This substance is found in the shops as a white powder, or as yellowish-white efflorescent crystals. This salt, as well as the antimonial wine and James's powder, may contain minute traces of arsenic, derived either from the metal antimony, or from the sulphuric acid used in its manufacture.

Properties.—Tartar emetic is very soluble in water, in about three parts of boiling and fifteen of cold water, but insoluble in alcohol; and it has a sickly metallic taste, and faint acid reaction.

Tests.—It may be necessary to examine the poison in a solid form, in solution, in organic mixtures, and in the fluids and tissues of the body.

1. *In Substance.*

a. When heated by the flame of a spirit-lamp it decrepitates and chars, and if the heat is increased by the use of the blowpipe, the

metal is reduced, but not sublimed. When treated with sulphuretted hydrogen, or sulphide of ammonium, the characteristic orange-red sulphide is formed.

2. *In Solution.*

a. A drop of a solution of tartar emetic evaporated on a slip of glass leaves a crystalline deposit. *b.* This deposit, examined by the lens or microscope, may contain well-formed crystals, which are either tetrahedra (figs. 41, 42), or cubes with the edges removed (fig. 43), or some modification of the cube. Sometimes all the crystals assume the one shape sometimes the other; but in many cases both kinds of crystals are to be found in the same specimen, as is shown in fig. 44; together

Fig. 41.

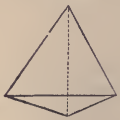
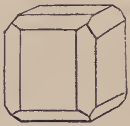


Fig. 42.

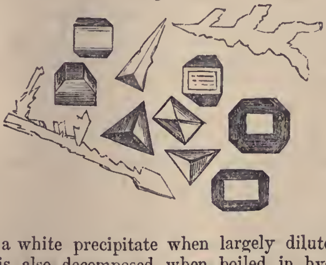
Fig. 43.



with the branched crystalline forms so common in collections of crystals obtained from solutions of salts. In fig. 41 the tetrahedron is shown, in the usual manner, by outline; in fig. 42, as generally seen under the lens or microscope.

c. The solution is proved to contain a salt of antimony by the orange precipitate which it yields with sulphuretted hydrogen gas, or sulphide of ammonium. The precipitated sulphide of antimony is soluble in caustic potash, in a large excess of ammonia, and in strong hydrochloric acid. The solution in hydrochloric acid has the characteristic property

Fig. 44.



of letting fall a white precipitate when largely diluted with water. The sulphide is also decomposed when boiled in hydrochloric acid, sulphuretted hydrogen being given off, and chloride of antimony remaining in solution; and it may be reduced to the metallic state by

heating it in a current of hydrogen gas. The indication afforded by this test is confirmed by the following tests: 1. The three dilute mineral acids throw down a white precipitate, which is re-dissolved by the acid in excess, and by a solution of tartaric acid. Of these acids the nitric acid is least open to objection as a test, but the three conjointly are conclusive as to the presence of antimony. 2. A strong infusion of gall-nuts gives a dirty yellowish-white precipitate. 3. Ferrocyanide of potassium causes no precipitate.

d. Introduce a portion of the solution into a Marsh's apparatus, and proceed as in the case of arsenic (p. 383). The crusts obtained on a slab of porcelain by inflaming the jet generally possess a less distinct metallic lustre, and a more smoky appearance than those of arsenic, but crusts are sometimes obtained which may be very readily mistaken for those of the latter metal. The crusts obtained by heating the horizontal tube have a characteristic shape (fig. 41, p. 384) and tin-like lustre. For the mode of distinguishing the crusts of the two metals, see p. 384.

e. Treat the solution after the method of Reinsch (p. 385), taking care to use a specimen of copper free from antimony as well as arsenic. The antimony deposited on the copper is generally of a violet tint. It may be dissolved off from the copper, either, 1, by boiling the metal in a weak solution of permanganate of potash rendered slightly alkaline by liquor potassæ (Dr. Odling); or, 2, by a weak solution of potash and the frequent exposure of the metal to the air (Mr. Watson, of Bolton). If the first process is adopted, the solution of antimony must be first freed from the brown deposit of the hydrated peroxide of manganese by filtration, then slightly acidulated with hydrochloric acid, and, lastly, treated with sulphuretted hydrogen gas. If the second process is adopted, the solution of the metal is first filtered, then acidulated with hydrochloric acid, and, lastly, treated with sulphuretted hydrogen.

f. The metal may be separated from liquids containing it by the process of electrolysis described at p. 387. The antimony is deposited on the platinum plate connected with the negative pole of the battery, and may be identified either by washing it with sulphide of ammonium, and evaporating the solution, or by either of the methods just described.

3. *In Organic Liquids.*

All vegetable substances containing tannin decompose the salts of antimony. Several other vegetable substances affect the action of the tests, and milk is coagulated by strong solutions of those salts. Coloured fluids, though they modify the action of the other tests, have little effect upon sulphuretted hydrogen, the precipitated sulphide retaining its characteristic colour. If no antidote has been given, and the poison has not been wholly rejected by vomiting, it may remain in the stomach unchanged. In this case we dilute, filter,

acidulate with tartaric acid, and transmit sulphuretted hydrogen gas through the liquid. If antimony is present we obtain the characteristic orange sulphide of antimony. If this process fails, we adopt for the solid contents of the stomach and the coats of the viscus the same method as for the organic tissues.

The discovery of antimony, by either method, in the contents of the stomach proves that some preparation of antimony has been taken, either as medicine, or as a poison. If the quantity discovered exceeds that of an ordinary medicinal dose, there is a strong presumption of poisoning; but when the quantity is small it will be impossible to state that it has been administered as a poison, unless it can be distinctly shown that it was not given as a medicine. Antimonial emetics ought never to be given in cases of poisoning, but the possibility of their being given should be borne in mind.

4. *In the Tissues.*

Antimony, like arsenic, is absorbed, and may be found in the secretions, in the blood, and in the solid viscera of the body. The process for detecting the poison in the blood or solid viscera is that already recommended for arsenic (p. 388). The resulting acid liquor may be treated after the method of Reinsch (p. 385), or that of Marsh (p. 381), or by electrolysis (p. 387). If by Reinsch's method the metal must be identified by the method just described: if by Marsh's method, by the characters described at p. 384.

Quantitative Analysis.—For this purpose use the precipitated sulphide of antimony, carefully washed and dried. One hundred parts correspond to 203 parts of crystallized tartar emetic.

Experiments on Animals.

Large doses of tartar emetic, such as half an ounce, may be given to dogs with impunity if they are allowed to vomit; but a few grains prove fatal when the gullet is tied. When injected into the veins, there is vomiting and purging, and marks of acute inflammation are found after death in the alimentary canal and in the lungs. In some instances of speedy death there was no inflammation in any organ of the body.

An interesting series of experiments on slow poisoning by antimony have been lately made by Dr. Nevins, of Liverpool ('Liverpool Medico-Chirurgical Journal,' No. 1), in illustration of the case of McMullen, whose death was attributed to the repeated administration of small doses of tartar emetic by his wife. The animals selected for experiment were rabbits, eleven in number, to which Dr. Nevins gave tartar emetic in powder, four times a day, in doses of half a grain, a grain, and two grains. The quantity required to destroy life was from twelve grains in a feeble rabbit to seventy-two in the longest survivor. Five of the rabbits died, the first after four, the last after seventeen days. Three survived after taking the poison seventeen days; and

three were killed, after one, three, and four days respectively, two after an interval of fourteen days, and one thirty-one days after taking the last dose of the poison.

The *symptoms* produced were *loss of appetite*, *loss of spirit*, and, after the sixth day, *great emaciation*. None of the rabbits *vomited*; and *diarrhœa* was absent in five out of eight. There were no *cramps*; but three of the five that died of the poison were violently *convulsed* for a few minutes before death, and a fourth slightly so. Several of the animals had *ulceration of the mouth*, where the powder came in contact with the lining membrane. One of the rabbits, being with young, aborted.

The *post-mortem appearances* consisted in *congestion of the liver* in all the rabbits, *vivid redness* of some part of the lining membrane of the *stomach* in most instances, *ulceration* in two; and cartilaginous hardness of the pylorus in some instances. The *small intestines* in some of the animals presented patches of inflammation throughout, and, in two instances, the *solitary glands*, throughout the bowels, were enlarged, prominent, of a bright-yellow colour, and loaded with antimony. The colon and rectum were nearly always healthy. In two instances the mucus of the stomach or bowels had a brownish colour, attributed to the formation of the sulphide of antimony. The *kidneys* were generally found more or less congested, and the bladder more vascular than usual, and distended with urine. This was not the case, however, in the animals that were killed after a few days, or some time after the discontinuance of the poison. The *brain*, *heart*, and *spleen* were always healthy, but the *lungs* in many cases were deeply congested, and in some acutely inflamed, sometimes hepatized, and gorged with blood; the air-tubes being of a bright-red colour. Bloody extravasations (or exudations) were found in the cavities of the chest and abdomen, and also between the muscular and mucous coat of the cæcum, in more than one instance.

The poison was found, by means of Reinsch's test, in every part of the body—*always* in the *liver*, and in great abundance; in smaller quantity in the *spleen;* at a later period of the poisoning in the *kidneys;* at the earliest period in the tissues of the *stomach*, and later in the *cæcum*. The fæces always contained the poison—in one rabbit killed fourteen days after the last dose, and in another twenty-one days after the poison had been discontinued. Antimony was also found in the *lungs* from an early period. In the *muscles* and in the *blood* it was difficult to detect; but it was found in the *bones* on the fifteenth day, and thirty-one days after the poison had been discontinued. The poison was also found in the fœtal rabbits, of which one of the poisoned animals aborted.

The poison was being constantly eliminated by the kidneys. It was discoverable in the urine after the twelfth dose; and in the urine voided twenty-one days after the poison had been suspended. This statement corresponds with, and confirms, what has been already stated

(p. 390), relatively to the slow elimination of arsenic from the system. From these experiments Dr. Nevins arrives at the following general conclusions: "that tartar emetic is a deadly poison when repeated in small doses for a sufficient length of time; but that the total quantity necessary for causing death, and also the length of time required, are very variable in different cases; that there is a considerable general similarity in the symptoms and morbid appearances produced, but by no means absolute uniformity; that the poison permeates almost all the tissues of the body, and even those of the unborn offspring, if its administration is continued long enough, whilst, at the same time, it is constantly being eliminated from the system by the kidneys and bowels; and lastly, that the fatal effects are often disproportionate to the apparent changes found after death."

These conclusions of Dr. Nevins are generally in harmony with the results of an experimental inquiry made by Messrs. Millon and Lavran in 1846. ('Annales d'Hygiène,' vol. xxxvi. p. 221.)

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of acute poisoning in the human subject are:—A strong metallic taste perceived in the act of swallowing, with heat, constriction and soreness of the mouth and throat, followed by nausea, vomiting, pain and tenderness of the epigastrium, extending to the whole abdomen, soon followed by repeated and profuse diarrhœa, with severe cramps of the extremities, and symptoms of collapse, namely, cold skin, clammy sweats, a small quick pulse, and great weakness. Death sometimes happens in this state of collapse; but it is sometimes preceded by severe nervous symptoms, such as convulsions, tetanic spasms, and delirium. Large doses of the preparations of antimony sometimes occasion insensibility as one of their earliest effects. In one instance the characteristic pustular rash was present on the skin and in the throat. In some exceptional cases vomiting has not been set up till other emetics have been administered.

Smallest Fatal Dose.—In an adult, two grains; in a child, $\frac{3}{4}$ of a grain. (Dr. A. Taylor, in 'Guy's Hospital Reports,' Oct. 1857.) In a healthy adult ʒi has destroyed life in ten hours. A grain and a half of tartar emetic with fifteen grains of ipecacuanha repeated on two successive days proved fatal with vomiting, purging, and prostration, in the case of a healthy woman five days after her confinement. ('Med. Times and Gaz.,' March 28, 1857.) Children have been killed by ten grains in a few hours. On the other hand, such large doses as ℥i of the poison have been frequently swallowed with impunity, in consequence of its prompt rejection from the stomach. Very severe effects have, however, been produced by so small a dose as six grains. It has often been given in inflammation of the lungs, in doses of two grains, repeated at short intervals, without producing any injurious effects.

Shortest Fatal Period.—Tartar emetic, in a single large dose, may

destroy life in a few hours; but, on the other hand, a patient survived nearly five days after taking forty grains of the poison.

Tartar emetic applied externally in the form of lotion or ointment excites inflammation of the skin and a crop of pustules, and, if continued, it may cause intense inflammation and sloughing. Nausea and vomiting have sometimes attended this external use of the poison.

Post-mortem Appearances. — Inflammation of the mucous membrane of the stomach extending sometimes to the small intestines, and rarely to the throat and gullet. In some instances inflammation in the lungs, and in the brain. In animals the lungs have been found inflamed.

Treatment.—The best antidote is tincture of cinchona bark. When this is not at hand, or cannot be immediately procured, the decoction or powder may be substituted. Any decoction or infusion containing tannin, such as tea, or decoction of oak bark, may also be used as an antidote. In the absence of the antidote, or while it is being prepared, vomiting should be promoted by warm water, milk, or mucilaginous drinks, or the stomach-pump may be employed. The after-treatment must be determined by the symptoms. General or local bloodletting may be necessary, and opium may be prescribed with advantage.

Chronic Poisoning.—The experiments of Dr. Nevins already detailed have removed any doubt which may have attached to recent medico-legal cases, as to the power of tartar emetic, in repeated small doses, to destroy life. The symptoms produced by such small repeated doses are, nausea, vomiting, and purging, with extreme debility, and gradual exhaustion.

Chloride of Antimony (Butter of Antimony).

This is a corrosive liquid of a light-yellow or dark-red colour, which has been taken by mistake for ginger beer and antimonial wine. When largely diluted with water the white oxychloride of antimony falls down, and the clear liquid is proved to contain muriatic acid by the addition of nitrate of silver. The subsidence of a white precipitate on the addition of water in excess is common to this substance and the salts of bismuth, but the colour produced in the liquid by sulphuretted hydrogen gas at once distinguishes the two bases. Bismuth yields a black, and antimony an orange-red precipitate.

Symptoms.—The action of the chloride of antimony is both prompt and violent. In one case, which proved fatal, death took place in ten hours and a half after swallowing between two and three ounces of the liquid. Narcotic symptoms were added to those of violent irritation of the alimentary canal, and after death the mucous membrane of the entire canal presented a charred appearance, and was softened and abraded. Recovery has taken place after swallowing an ounce of the poison.

Treatment.—That of poisoning by tartar emetic. Diluents should be largely and promptly administered.

3. MERCURY AND ITS PREPARATIONS.

Mercury and its preparations are in common use in the arts and in medicine, and they are occasionally used as poisons. They take the seventh place among the ascertained causes of death by poison, coming next after oxalic acid, and they are credited by the Registrar-General with ten deaths a year, on the average of the five years 1852-56. Corrosive sublimate, the preparation usually taken or given as a poison, was the cause of twelve out of 543 deaths from poison in 1837 and 1838; of which twelve cases two were accidental, and nine suicidal. Metallic mercury, as used in the arts, gives rise to severe and well-defined maladies, and the preparations of mercury used as medicines occasionally prove fatal when given in an over dose, or in an ordinary dose to persons very susceptible of their action. The metal itself is inert, and may be given in very large doses without injury; but its oxide when diffused through the air, or brought into constant contact with the skin, is well known to produce injurious effects.

One important property of metallic mercury requires to be noticed, as it is made use of in medico-legal inquiries. It sublimes unchanged at 660°, and if the sublimation is conducted in a glass tube, a ring of small metallic globules forms on the cool part of the tube. In a still more minute state of division it has the appearance of a black powder; and it is in this form that the metal is thrown down from the solution of its salts.

The most important salts and preparations of mercury are:—the chloride or corrosive sublimate; the sub-chloride, or calomel; the ammonio-chloride, or white precipitate; the red oxide, nitric oxide, or red precipitate; the sulphide, cinnabar, or vermilion; the sub-sulphate of the oxide, or Turpeth mineral; the bicyanide, or prussiate of mercury; and the two nitrates of mercury. The black sub-oxide, and sub-sulphide are of less importance.

Of these preparations of mercury by far the most important is corrosive sublimate.

CORROSIVE SUBLIMATE.—(*Oxy-muriate, Corrosive Muriate, Bichloride*, more properly *Chloride, of Mercury.*)

This preparation of mercury is used for preserving the feathers of birds and skins of animals from moth, also for destroying bugs and for killing lice and maggots in man and in animals; and it is a favourite remedy, when dissolved in spirits of sweet nitre, for gonorrhœa and syphilis.

Properties.—This poison is found as a very heavy crystalline mass, or as a white powder, of a peculiarly nauseous styptic metallic taste, permanent in the air, but slowly decomposed in sunshine, an insoluble grey powder being formed. It is soluble in twenty parts of tem-

perate, and in two parts of boiling, water. It is more soluble in alcohol and ether, for which reason ether is used to remove it from its aqueous solution. Common salt, also, increases its solubility.

Tests.—We may have to examine the poison in substance, in solution, in organic liquids, and in the tissues and organs of the body.

1. *In Substance.*

On the supposition that we are ignorant of the nature of the substance submitted to analysis, we first test it by the heat of a spirit lamp. It first melts in its water of crystallization, and is then completely volatilized; giving off white acrid irritating fumes. If heated in a test tube, it deposits long silky crystals on the cool sides of the tube. Collected on a flat surface of glass these crystals are arranged as in fig. 45, or they assume the stellate form shown in fig. 46. As arse-

Fig. 45.

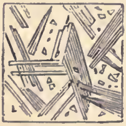


Fig. 46.

nious acid treated in the same way yields octahedra, and calomel an amorphous deposit, the twofold test of heat and crystallization, is almost conclusive of the nature of the substance. The great solubility of corrosive sublimate in water further distinguishes it from arsenic and calomel. The addition of a few drops of liquor potassæ places the nature of the substance beyond a doubt. Corrosive sublimate is changed to a yellow colour, while arsenic undergoes no change, and calomel is blackened. We may obtain still further assurance by the following tests: 1. Sulphide of ammonium blackens the powder. 2. A solution of iodide of potassium turns it to a bright scarlet. 3. Moisten a clean rag with dilute hydrochloric acid, sprinkle the powder upon it, and rub it on a clean plate of copper. A silvery stain is formed which is readily volatilized by heat. 4. Mix one part of the poison with four parts of calcined carbonate of soda; place the mixture in a reduction tube (fig. 16, p. 371), or in the short tube (fig. 17, p. 372), and cautiously apply the heat of a spirit lamp, having previously dried the upper part of the tube. A ring of globules will be formed on the cool sides of the tube, or on the disc of glass placed over its mouth.

2. *In Solution.*

a. On the supposition that we are ignorant of the contents of a liquid submitted to analysis, we may ascertain that it contains a crystal-

line salt by evaporating a portion of the liquid on a flat piece of glass, and may examine the crystal, if necessary, under the microscope. Corrosive sublimate is deposited, in part, in long single needles, branched or stellate, as in figures 45, 46. *b*. Or we test for a base by sulphuretted hydrogen, which yields with corrosive sublimate a black precipitate, first giving a milky white appearance to the liquid. *c*. Sulphide of ammonium also gives a black precipitate. *d*. With liquor ammoniæ it yields, in common with lead and bismuth, a white precipitate, but with liquor potassæ a yellow (the hydrated oxide). By this we recognize a per-salt of mercury. The supernatant liquor contains chloride of potassium, and if we add to it nitrate of silver we obtain the white chloride of silver, which proves that the salt of mercury is a chloride. The colour of the precipitate with liquor potassæ shows that it is a per-salt. *e*. This precipitate being collected, washed, and dried, and heated in a reduction tube, gives a well-defined ring of mercury. The sulphide precipitated by sulphuretted hydrogen, or by sulphide of ammonium when dried and heated with bicarbonate of soda, also yields a ring of mercury. By using either precipitate for that purpose we obtain conclusive evidence of the presence of mercury.

The following are additional tests: 1. Protochloride of tin. A solution of this substance throws down a white precipitate, turning rapidly to grey, and from grey to black. The black deposit is minutely divided mercury. The supernatant liquor being decanted or separated by filtration, and the deposit dried, the globules coalesce. 2. Metallic test. Acidulate the liquid with a few drops of hydrochloric acid, and introduce into it a narrow slip of clean copper. A grey film will be formed on the surface of the metal. This being carefully dried, introduced into a reduction tube, and heated with the flame of a spirit lamp, yields a ring of metallic globules deposited on the upper part of the tube. Pure tin, zinc, or silver may be substituted for copper; but the latter is to be preferred. 3. Galvanic test. Take a narrow strip of zinc foil, moisten it, and take up as much gold leaf as will adhere to it. Introduce this into the solution slightly acidulated with hydrochloric acid; the gold will soon be covered with a grey film. Remove it from the solution, dry it carefully, introduce the dried metal into a reduction tube, and apply the flame of a spirit lamp. A ring of metallic globules will be formed. This test is extremely delicate, and it is applicable to the discovery of very minute quantities of the poison. The metallic deposit may be readily obtained by placing a drop of the acidulated solution on a surface of clean copper or gold, and touching the moistened metal with a fragment of zinc or iron. Dr. Wollaston once employed a key and a sovereign for this purpose.

Mercury is one of the metals which is deposited on copper when its solutions are treated after the method of Reinsch (p. 385). The deposit is known as mercurial by drying the copper, and heating it in a reduction tube, when a ring of metallic mercury will be formed.

The acid in combination with the mercury may be shown to be the

hydrochloric by testing the fluid from which the mercury has, by any of the foregoing methods, been precipitated. On the addition of the nitrate of silver we obtain a white precipitate of chloride of silver.

3. *In Organic Liquids.*

Corrosive sublimate is sometimes swallowed in substance, or in a state of imperfect solution; and though it is very soluble, may be found in the stomach in a solid form, and may be separated by merely diluting the viscid liquid with distilled water, stirring it, allowing the heavy corrosive sublimate to subside, and quickly pouring off the supernatant liquor. More commonly the poison is given in solution in water or in some liquid suited to disguise its taste; and when so given it may be decomposed by the contents of the stomach, or by the mucous membrane itself. The poison may, therefore, exist in the stomach partly in solution undecomposed, partly in combination with the contents of the stomach, and partly in union with its coats.

If any portion of the poison exists in the free state, it may be readily separated by diluting the contents of the stomach with distilled water, obtaining a clear liquid by filtration, shaking it in a stoppered bottle, with an equal bulk of ether, and drawing off the ethereal solution with the pipette. If the ether has dissolved any of the corrosive sublimate, it will be readily identified by evaporating a portion of it on a surface of glass. The crystals depicted at p. 408 will remain behind. They may be dissolved in distilled water, and the solution tested by the reagents already described.

The solid contents of the stomach may be conveniently examined by the same method as for the organic tissues.

4. *In the Organic Tissues.*

Bring the organic matters into a state to pass the filter by the method described at p. 389; and test the liquid by the method of Reinsch (p. 385). If the copper receives a grey coating, wash it in distilled water, dry it, and heat it in a reduction tube (fig. 16, p. 371). Globules of metallic mercury will be deposited on the cool side of the tube, or on the covering of thin glass (fig. 17, p. 372). When we have to deal with small quantities of mercury, as will be the case in examining the tissues of the body, we should employ the form of reduc-

Fig. 47.

tion tube figured at p. 378, in the manner described when speaking of the detection of minute quantities of arsenic. This test is one of

great delicacy. The five-thousandth part of a grain can be readily sublimed and identified. The appearance of a group of globules obtained from this small quantity of the metal is shown in *a* fig. 47, where they are magnified 70 diameters and measure $\frac{1}{200}$ inch. Sometimes the metal is oxidised, and then presents the appearances depicted in *b* fig. 47. Among spots of no very defined shape are to be found a number of prismatic crystals, some scarcely longer than their breadth, while others are long needles.

As arsenic, when deposited on copper by Reinsch's process, and then sublimed in the same way as mercury, also yields distinct globules, it will be necessary to distinguish the one from the other. The globules of arsenic are sometimes quite as brilliant as those of mercury, and are, therefore, not to be distinguished from them; but generally they do not present so smooth a surface. They are somewhat granular in appearance, while the globules of mercury are quite smooth. The difference between them is such as is shown in fig. 48. But the

Fig. 48.

(Magnified 150 diameters.)

metallic lustre which belongs to the globules cannot be properly represented by wood engraving. It would evidently be unsafe to rely on this comparatively slight difference. The distinction, however, is rendered easy by the fact that the globules of arsenic, as obtained by this process, are always blended with the characteristic octahedral crystals of arsenious acid, while those of mercury are either unmixed, or blended with the small needles just described and figured. The arsenical sublimate, when obtained in the presence of atmospheric air, is either found to consist wholly of crystals, or the crust is compounded of globules and crystals, the globules occupying the part of the tube nearest the flame of the lamp, and the crystals the part more remote.

In the case of a liquid found in the stomach, or obtained by simple boiling, yielding mercury by any of the processes now described, we have evidence of a soluble salt of mercury, and a strong presumption in favour of corrosive sublimate; but when the solid matters after evaporation to dryness are treated with hydrochloric acid, we have no evidence of a soluble salt, because even an insoluble salt, thus treated, would be converted into corrosive sublimate. This process, then, is open to the objection that the mercury which it is the means of discovering may have been administered for medicinal purposes in

the form of calomel, blue pill, or grey powder. This objection could only be answered by distinct evidence of such substances not having been administered as medicine, or by the characteristic symptoms and post-mortem appearances due to corrosive sublimate being present.

Corrosive sublimate, like arsenic and other active poisons, may be rejected from the stomach so as not be detected after death.

Quantitative Analysis.—Though the presence of mercury may be ascertained by the methods already described, the quantity of the poison is best determined by means of the protochloride of tin. When the poison is in solution, the protochloride of tin should be added so long as any precipitate falls. The precipitate should then be washed, dried, and weighed.

When there is reason to believe that the quantity of corrosive sublimate is considerable, we may follow with advantage the summary process recommended by Dr. Christison. The solid matters are to be triturated, without previous filtration, with protochloride of tin, when the mixture will assume a slate-grey colour, and separate readily into a liquid and coagulum. The liquid may be rejected, but the coagulum, having been washed on a filter, must be carefully removed and boiled in a moderately strong solution of caustic potash, until all the lumps disappear. The oxide of tin with the animal and vegetable matters are thus dissolved, and the solution, on remaining at rest, deposits a heavy grey powder, consisting chiefly of finely divided mercury. To separate the mercury completely, the solution must be allowed to remain at rest, at a temperature little short of boiling, for about twenty minutes. The supernatant liquor may then be drawn off, and the remaining black powder after repeated washings may be removed, heated, and sublimed. This process is a very delicate one. Of the metallic mercury thrown down by the protochloride of tin, a hundred grains correspond to one hundred and thirty-five grains of corrosive sublimate.

Experiments on Animals.

The experiments of Sir Benjamin Brodie show that corrosive sublimate is a very active poison. Six grains dissolved in six drachms of water killed a rabbit in 4½ minutes, and a scruple proved fatal to a cat in twenty-five minutes. The rabbit became insensible in three minutes, and was convulsed; and on opening the chest the heart had ceased to beat, and its left cavities contained scarlet blood. The mucous membrane in the cardiac portion of the stomach was of a dark-grey colour, much softened and readily detached; but similar effects were produced by the action of the poison after death. Sir B. Brodie attributed the fatal effect of the poison to this chemical action on the mucous membrane. Dr. Bostock and other experimenters, by administering smaller doses, produced the common symptoms of irritant poison, followed by death after some hours; and the appearances on dissection of active irritation and inflammation of the mucous membrane of the stomach.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Immediately, or within one or two minutes of swallowing a substance or liquid of a peculiarly nauseous, metallic, and styptic taste, there is a sense of tightness and burning in the throat and gullet, greatly increased by pressure, and on every attempt to swallow, and speedily followed by burning pain in the epigastrium, also increased on pressure. Vomiting and purging of stringy mucus or of bilious matter often containing blood ensue, and the entire abdomen becomes distended and exquisitely painful. The face is generally flushed and swollen and the eyes sparkling; but in other cases the countenance is pale and anxious, the lips white and shrivelled, and the eyes dull but expressive of great anxiety. The diarrhœa is accompanied with tenesmus, and dysuria is often present, the secretion of urine being scanty or altogether suppressed. The pulse is full, quick, and frequent, or small, frequent, and intermittent, according as the symptoms are those of high fever or of collapse, and the breathing is quick and catching. There are sometimes intervals of comparative ease, during which the patient is drowsy; and this drowsiness sometimes amounts to coma. Nervous symptoms, consisting of cramps, twitches, and convulsions of the limbs, are often present from an early period; and occasionally there is paralysis. Death takes place during a fainting fit, in the midst of strong convulsions, or during protracted insensibility. To these symptoms, in most cases which do not prove rapidly fatal, salivation is superadded, and the painful train of nervous symptoms caused by the specific effect of mercury on the system. These characteristic effects of the poison will be presently examined.

The symptoms of poisoning by corrosive sublimate are by no means uniform, nor is the mode of death always the same. Three varieties of cases at least may be recognized:—1. Violent irritation of the stomach and bowels, with collapse. 2. Salivation and other remote effects, with little or no irritation of the alimentary canal. 3. Irritation of the stomach and bowels, followed by salivation and remote constitutional effects.

Mercurial Salivation.—A coppery taste, a peculiar fetor of the breath, tenderness and swelling of the mouth, inflammation swelling and ulceration of the gums, and an increased flow of saliva, are the familiar symptoms of mercurial salivation. These symptoms vary greatly in severity in different cases. In the more severe forms the salivation is profuse; the face, neck, and tongue, swollen; the inside of the mouth ulcerated or gangrenous. These local affections are preceded or accompanied by a frequent pulse and hot skin, and other symptoms of fever.

Several interesting questions suggest themselves in connexion with this symptom of mercurial poisoning. *a.* What is the smallest dose which will occasion salivation? *b.* Can salivation be produced by other causes, and if so, can we distinguish such salivation from the

effects of mercury? *c.* What is the earliest period at which salivation may occur? *d.* What is the duration of mercurial salvation? *e.* Can salivation cease and recur without a renewed use of the mercurial preparation? *f.* Is it possible to distinguish gangrene of the mouth, the effect of mercury, from the same disease due to other causes?

a. Smallest dose required to occasion salivation. There is much difference between different individuals, between persons of different ages, and even in the same person at different times, in respect of the quantity of mercury which they can bear. As a general rule, children are less susceptible of the action of mercury than adults, the robust than the delicate. The same female who in her ordinary state of health is affected with difficulty, shall, when suffering from anæmia, be salivated with a few doses of blue pill. In affections of the nervous system, also, very marked effects are often produced by small doses of mercury.* Again, there are many persons peculiarly susceptible of the action of mercury, and others whom the largest doses continued for a considerable period will not affect. Many instances of severe and even fatal effects produced by small doses are on record. In one case given on the authority of Dr. Bright, five grains of calomel placed on the tongue of an apoplectic patient produced in three hours violent salivation, and such swelling of the tongue as to render scarifications necessary. Three grains of corrosive sublimate in three doses has caused violent ptyalism: three five-grain doses of blue pill, given one every night, have proved fatal; two grains of calomel have caused ulceration of the throat, exfoliation of the jaw, and death; and the external application of three drachms of mercurial ointment has destroyed life in eight days. ('Christison on Poisons,' p. 379.)

b. Can salivation be produced by other causes, and if so. can we distinguish such salivation from the effects of mercury? Salivation may occur spontaneously, so as to constitute a disease in itself, or it may be due to the mere accumulation of saliva, in consequence of some disease of the throat, such as quinsy, preventing deglutition. It may even be occasioned by the influence of the imagination, as in a case related by Christison (p. 382). Various preparations of gold, copper, lead, arsenic, antimony, and bismuth, sulphuric acid, iodine, and iodide of potassium; several substances derived from the vegetable kingdom, such as castor-oil, fox-glove, opium, and prussic acid, have also given rise to salivation.

The distinction between mercurial salivation and that dependent upon other causes is generally easy, in the first stage. Mercurial salivation is preceded by the coppery taste and fetor of the breath, and accompanied by redness, sponginess, and ulceration of the gums. These are wanting in spontaneous salivation, and in that produced by

* In a case of paralysis of the facial nerve which came under my notice, there was a distinct red line upon the gums of the paralyzed side, while the other was quite free. The sensibility of the affected side was perfect, though the patient complained of a sensation of tingling.

most of the medicines just mentioned.* But the advanced stage of mercurial salivation seems to differ less strikingly from some severe affections of the mouth due to other causes, and accompanied by ptyalism. Thus in a curious account of an epidemic salivation, forming a part of a tertian fever, quoted from Haller's Collections on the authority of Quelmelz, it is stated that in one instance it was as great as the most violent mercurial salivation, and was accompanied by fetor, superficial ulceration of the mouth, pustules on the tongue, relaxation of the gums, and looseness of the teeth. (Christison, p. 382.)

c. What is the earliest period at which salivation may occur? Mercurial salivation rarely sets in under twenty-four hours; but in Dr. Bright's case already cited, it appeared in three hours. In a case of poisoning by two drachms of corrosive sublimate, it began in four hours. (Taylor.) The shortest period, therefore, may probably be stated at three hours.

d. What is the duration of mercurial salivation? The duration of mercurial salivation is very variable, and may be very considerable. It may continue for any period from a few days to as many years. In one instance it is alleged to have lasted six years. ('Lancet,' No. 453.)

e. Can salivation cease and recur without the renewed use of the mercurial preparation? This question may be safely answered in the affirmative. Dr. Robert Williams ('Elements of Medicine,' vol. ii., p. 523) gives a case on the authority of Dr. Daniel, in which salivation was suspended for eight or nine days under an attack of remittent fever, and then returned, though not a grain of mercury had been given after the accession of the fever. Instances of recurrence of salivation after three and even four months are on record; but in one case at least (Christison, p. 381) the recurrent salivation was unattended by fetor, redness, ulceration, or sponginess of the gums. The possibility of recurrent mercurial salivation is also confirmed by analogy; for in the case referred to in the note at the foot of this page, the salivation is proved to have taken place after the iodide of potassium had been suspended for several weeks.

f. Can gangrene of the mouth, the effect of mercury, be distinguished from the same disease due to other causes? We have no certain diagnostic marks Cases of *cancrum oris* following debilitating diseases, or occurring in children badly lodged and badly fed are not of very rare occurrence. In such cases it very seldom happens that mercury in some form has not been given. Hence, a difficult question may arise as to the cause of the disease. In the absence of any exact means of discrimination, it may be sufficient to state that extreme debility, brought on by any of the causes just mentioned, is a sufficient

* A case now under my care seems to justify the cautious statement in the text. All the symptoms of severe mercurial salivation are present as the effect of a course of iodide of potassium, in the ascertained absence of mercurial preparations, other than those given from time to time as aperients, such aperients not having previously affected the system.

cause of gangrene; and that even if the mercury which may have been given have contributed to the fatal result, the medical man is not to be blamed for the use of a medicine of great value in the diseases of children, and which less frequently causes salivation in them than in adults. It is generally stated that gangrene, the effect of mercury, may be distinguished by its beginning in the mucous membrane of the mouth and throat, while the cancrum oris begins in the skin of the cheek or chin. This statement is without foundation; for in a fatal case of mercurial salivation which occurred under the care of Dr. John Bright, of the Westminster Hospital, the gangrene began as a small black spot between the lower lip and chin. Other cases of the same kind are on record.

Mercurial Tremors, Shaking Palsy, Tremblement Métallique.—This disease occurs in men whose work exposes them to the fumes of mercury, or causes them to handle the oxide so as to absorb it by the skin; such as quicksilver miners, water gilders, mirror silverers, and barometer makers. It sometimes begins suddenly, sometimes comes on gradually; and is sometimes attended by salivation, sometimes not. The upper extremities are commonly first affected, and then, by degrees, all the muscles of the body. In the more strongly-marked cases the patient can neither speak, masticate, nor walk. The unsteadiness of the arms prevents him from grasping any object, and the muscles of the legs are so convulsed that he cannot plant his foot firmly on the ground, and when he tries to walk, his gait soon becomes an unsteady dancing trot. If the patient so affected does not give up his work, he loses his memory, is unable to sleep, becomes delirious, and so dies. On leaving off his work he generally gets well, but the recovery may occupy some weeks or months. Sometimes the disease does not admit of cure. The absorption of the poison is sometimes indicated by a blue mark on the gums, as in lead poisoning, but more commonly by a dark red line; and a curious symptom not generally recognised, though very commonly present, is a brittle state of the teeth, causing them to chip. The preventive treatment of this affection consists in cleanliness and ventilation; and the swallowing of white of egg in water three or four times a day may be recommended.

Post-mortem Appearances.—Corrosive sublimate and the soluble salts of mercury give rise to post-mortem appearances differing little from those due to other corrosive poisons. The effects are intermediate between those produced by the corrosive acid poisons and those caused by the stronger non-corrosive irritants, such as arsenic. Corrosion, softening, and sloughing ulceration of the stomach and intestines are of frequent occurrence, and the peritoneum is often found inflamed. The sloughs have been found to yield mercury on analysis. Sometimes the small intestines escape, and the poison acts only on the stomach and on the rectum, or on the large intestines generally. The decomposition of the salt by contact with the mucous membrane, or with the contents of the stomach, or with antidotes, and the consequent deposition of

mercury in a state of minute division on the lining membrane, as a thin slate-coloured covering, sometimes serves to identify the poison. When the body is in a state of decay, a similar appearance of the mucous membrane may be caused by the action of sulphuretted hydrogen, giving rise to the formation of the black sulphuret. When mercurial salivation has existed during life, we shall find the mucous membrane of the mouth inflamed or sloughing.

One post-mortem appearance which has been more frequently encountered as the result of poisoning with corrosive sublimate than as a consequence of poisoning with arsenic, is the highly inflamed state of the urinary organs, and the contracted state of the bladder, corresponding to the very scanty secretion of urine during life.

Corrosive sublimate applied to the mucous membrane after death causes it to assume a white, wrinkled, and granulated appearance. It is also harder than natural, and of a dead whiteness, with rose-coloured vessels ramifying upon it. These appearances extend to the muscular and peritoneal coats. They were found by M. Orfila, in the mucous membrane of the rectum, with which corrosive sublimate in powder had been brought in contact after death. In the experiments of Sir B. Brodie the same effect was produced on the mucous membrane during life and after death.

Smallest Fatal Dose.— *Three* grains have proved fatal in the case of a child. Very large doses have been swallowed with impunity, having been rejected by vomiting, or decomposed by the prompt use of antidotes.

Shortest Period.—Death may occur in *two* hours. The nitrate of mercury has proved fatal in two hours and a half. In the case of this poison, as in that of arsenic, the period is extremely variable.*

Treatment.—The antidotes to corrosive sublimate are albumen, gluten, iron filings, a mixture of gold dust and iron filings suspended in gum water, and the hydrated protosulphuret of iron. The antidotes most readily procured are the white of egg and gluten. The white of egg should be given freely mixed with water, as long as urgent symptoms are present, and accompanied, if necessary, by emetics and diluents. If eggs cannot be procured, flour mixed with water, or milk, may be substituted. White of egg has been proved to be an efficient antidote in so many cases, that where it is at hand it is quite unnecessary to resort to any other.

The rest of the treatment will not differ from that proper to poisoning by the irritants generally. Where salivation is present, cool air, cold drinks, and gentle aperients, with gargles of alum or chloride

* The following periods are on record:—one of 2 hours; one of $2\frac{1}{2}$ hours; one of 3 hours; one of 6 hours; one of 11 hours; and one of 3, 6, 8, and 11 days respectively. Of these nine cases, then, about half the number died in less than 12 hours, and the remaining half in a period varying from 3 to 11 days.

The reader is referred to the following cases of poisoning by corrosive sublimate:—Medical Gazette, vii. 329; viii. 616; xxix. 797; xxxi. 556. Ed. Med. and Surg. Journal (five cases by Mr. Valentine), xiv. 468; li. 114; liii. 404; lviii. 505.

of sodium, must be used; and in very severe cases, large doses of acetate of lead. Occasionally, when the inflammatory symptoms run high, local or general blood-letting may be resorted to.

Corrosive sublimate acts as an irritant poison, and produces its characteristic effects in whatever way it may be introduced into the system.

CALOMEL (*Subchloride of Mercury, Protochloride of Mercury*).

Properties.—Calomel is a heavy white or yellowish-white powder, insoluble in water, and in alcohol and ether, but soluble in nitric and hydrochloric acids.

Tests.—On the supposition that we are ignorant of the nature of the powder, we first apply heat, which, as in the case of corrosive sublimate and arsenic, volatilizes it. If heated in a tube, it is deposited on the cooled glass as an amorphous powder. Its insolubility in water at once distinguishes it from corrosive sublimate, but not from arsenious acid. It is turned black by sulphide of ammonium, liquor potassæ, and liquor ammoniæ. It resembles corrosive sublimate in the action of protochloride of tin upon it: heated with carbonate of soda, it yields a sublimate of metallic mercury, and it gives a silvery stain when rubbed with dilute muriatic acid on copper.

Calomel, though generally a safe medicine when given in moderate doses, and administered in many diseases in large quantities often repeated, sometimes produces very violent effects, acting either as an irritant poison, or destroying life by producing gangrene of the mouth and throat. Cases are on record of fatal results following a single dose of a scruple, and quantities so small as fifteen, eight, and six grains. On the other hand, doses of three drachms, and of one ounce have been taken without fatal consequences. In the Asiatic cholera, and in many of the severe fevers of hot climates, calomel in repeated doses of one scruple has been found highly beneficial; and in the case of the cholera has rather allayed than increased the irritation of the alimentary canal.

The violent effects produced by calomel in exceptional cases have been attributed to its partial conversion into corrosive sublimate by the free hydrochloric acid of the stomach, or by contact with some chloride, as the chloride of sodium, or the muriate of ammonia. The quantity of corrosive sublimate formed by the first of these reactions must be extremely small, as free hydrochloric acid exists in the stomach in very minute proportion. On the other hand, experiment has shown that the quantity of corrosive sublimate formed by admixture with chloride of sodium at the temperature of the stomach itself is extremely small, and insufficient to account for the fatal result. A minute quantity of corrosive sublimate is found mixed with calomel; but this, too, has been shown by Dr. Christison to be insufficient to account for the occasional poisonous effects of calomel. In ten different speciemns of calomel examined by him, the quantity of corrosive sublimate did not exceed a five hundredth of its weight.

The other compounds and preparations of mercury possess poisonous properties; but as these have been very rarely taken as poisons, a very brief description of their properties will suffice.

Red Precipitate (red oxide of mercury).—This substance is largely used, mixed with lard or grease, for destroying vermin. The crystals of the red precipitate are small, brilliant, and of a scarlet or deep orange colour; the powder is orange coloured. It is very heavy, insoluble in water, but soluble in warm hydrochloric acid, which converts it into corrosive sublimate. When heated in a small glass tube it is entirely dissipated, metallic globules are sublimed, and oxygen gas is given off.

Cinnabar, Vermilion (bisulphuret of mercury).—This substance is found in commerce in the form of a dark red semi-crystalline mass, or in that of a fine red powder. The former is cinnabar, the latter vermilion. When thrown down from a solution of a per-salt of mercury by sulphuretted hydrogen, it is black; but, when sublimed, becomes red. It is heavy, insoluble in water and muriatic acid, entirely dissipated by heat, but collects on the sides of the tube unchanged. When mixed with carbonate of soda, and heated in a reduction tube, globules of metallic mercury are sublimed; and on adding a mineral acid to the residue, sulphuretted hydrogen is given off, showing the presence of sulphur.

White Precipitate (ammonio-chloride of mercury).—This is found in the form of a white heavy powder, insoluble in water, and entirely dissipated by heat. It yields with carbonate of soda a metallic sublimate. The ammonia may be detected by boiling the powder in liquor potassæ. The gas is given off, chloride of potassium is formed, which may be detected by the nitrate of silver test, and the yellow peroxide of mercury remains.

Turpeth Mineral (sulphate of the oxide of mercury).—This is a heavy yellow powder, sparingly soluble in water, and yielding, when heated in a glass tube, a metallic sublimate, with fumes of sulphurous acid gas. When boiled in a solution of potash, the yellow peroxide is thrown down, and a sulphate of potash is formed, the acid of which may be identified by the nitrate of baryta test.

Nitrates of Mercury (nitrate and subnitrate).—The nitrate of mercury is found in the form of white crystals, which are very soluble in water, the solution being highly acid and corrosive. When heated in a tube, the crystals give off nitrous acid gas, and a ring of metallic globules is sublimed. When mixed with carbonate of soda and heated, metallic mercury is sublimed. On adding liquor potassæ to a solution of the salt, a yellow precipitate is thrown down. The acid is readily detected by adding carbonate of potash till effervescence ceases, and filtering the resulting liquid; nitrate of potash remains in solution.

The subnitrate differs from the nitrate, inasmuch as liquor potassæ throws down a black precipitate from a solution of the former, and a yellow precipitate from that of the latter.

Bicyanide of Mercury (prussiate of mercury).—This salt is in the

form of white, heavy, inodorous crystals, which have a strong metallic taste, are soluble in hot and cold water, and nearly insoluble in alcohol. When heated, the crystals yield metallic mercury and cyanogen gas, which is recognised by the characteristic purple colour of its flame. When heated with hydrochloric acid, hydrocyanic acid is given off. The solution yields with sulphuretted hydrogen, and sulphide of ammonium, a black precipitate, but it is not precipitated by liquor potassæ.

All the foregoing preparations of mercury have, in rare instances, been taken as poisons. Their activity is proportioned to their solubility. Thus the soluble nitrates and the bicyanide of mercury even in small doses are extremely active poisons, while the white and red precipitate, the turpeth mineral, and vermilion act much less powerfully. The soluble salts act as corrosive poisons, the insoluble compounds simply as irritants. Both classes may produce the specific effects of mercury. In poisoning by the bicyanide of mercury, the symptoms are those of poisoning by a soluble salt of mercury. The cyanogen, which is in combination with the mercury, does not seem to modify the action in any material degree.

Two cases of poisoning by red precipitate occurred in the practice of Mr. A. Prince, of the Harrow Road, and are reported in the 'Medical Times and Gazette,' November, 1859. In one of the cases, the symptoms of acute irritant poisoning, were followed, (the dose being two drachms,) on the third day by violent salivation, with extensive destruction of the soft parts.

4. LEAD AND ITS PREPARATIONS.

Acute poisoning with the salts of lead is an event of rare occurrence. One case only of poisoning (by Goulard's extract) occurred in the two years 1837-8; and although no less than twenty-three deaths from the "salts of lead" are returned by the Registrar-General for the average of the five years 1852-56, it is obvious that they are chronic cases. No case of lead poisoning occurs in the five years in the lists of suicides, murders, and manslaughters. From the great use made of lead in the arts, its effects as a slow poison are familiar to every medical man.

The metal itself does not possess any poisonous properties; but as it is readily acted on by acids, it may become poisonous by combining with the contents of the stomach.

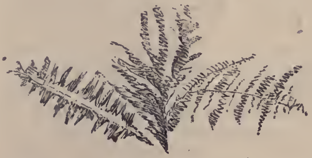
The preparations of lead which are used in medicine or the arts, are the two oxides, the carbonate, the acetate and subacetate, the sulphate, the chloride, and the nitrate. Of these, the carbonate and the acetate are most important in a medico-legal point of view.

Tests for the Salts of Lead.—On the supposition that we are ignorant of the nature of a base contained in a solution presented for analysis, we first transmit sulphuretted hydrogen through it, or add a few drops of the sulphide of ammonium. Lead is one of those bases which give with this reagent a black precipitate. Liquor ammoniæ,

liquor potassæ, and dilute sulphuric acid throw down a white precipitate. By this succession of trial tests, the solution is known to contain a salt of lead.

The base is still further identified by the following tests: 1. Chromate of potash throws down a gamboge-yellow chromate of lead. 2. Iodide of potassium yields an iodide of lead of the same colour. 3. If a fragment of zinc the size of a pin's point be placed in a drop of the solution, the lead is deposited in one of the annexed forms. The lead tree is developed very rapidly and should be examined under the

Fig. 49.



microscope before the form has become obscured by the formation of the white carbonate. This test acts characteristically on one grain of the acetate of lead in four ounces of distilled water.

These tests are sufficient to identify the base, and may be applied to any of the soluble salts of lead.

Oxides of Lead.—There are three oxides of lead: the protoxide, red lead, and the peroxide. The protoxide, in the form of a yellow semi-crystalline glass, is the *litharge* of commerce; in that of a fine powder, it goes by the name of *massicot*. A combination of protoxide and peroxide of lead is the minium, or red lead, of commerce. The brown peroxide is little known out of the laboratory.

Litharge (protoxide of lead).—This is in common use by painters and glaziers, and is used as a cheap glaze for the common kinds of earthenware. Serious accidents have arisen from this glaze being acted upon by acids. Litharge has also been used to impart a sweet taste to sour wines. As already stated (p. 5), it is a constituent of the hair dyes in common use. It possesses the following properties: it is found in the form of reddish or yellowish scales, which are volatile at a red heat, insoluble in water, but perfectly soluble, when pure, in nitric acid, the solution possessing the properties of nitrate of lead, and the base giving the reactions already described. When placed on a piece of charcoal, it is readily reduced by the heat of the blow-pipe.

Minium or Red Lead.—This is the common colouring matter of the red wafers; and it has been found mixed with snuff. It is in the form of a rich red powder, insoluble in water, and but partially dissolved by nitric acid. When heated, it gives off oxygen, and is reduced to the orange-yellow protoxide of lead. It is readily reduced under the blow-

pipe on a fragment of charcoal, and on burning the wafers which contain it, little globules of lead will be observed to form on the edges, mixed with the unreduced yellow protoxide.

White Lead (ceruse, carbonate of lead).—This is extensively used in the arts, chiefly as the basis of colours, and for enamel cards, and, so used, is among the most common causes of colica pictonum and of other forms of chronic poisoning by lead. It is sold in white masses, or as a heavy white powder, and possesses the following properties: When heated to redness, it loses its carbonic acid, and is changed to the yellow protoxide. It is insoluble in water, but soluble with effervescence in nitric acid. If quite pure, it is completely soluble in the acid; but as it is usually found mixed with some sulphates, it is not completely dissolved. In large doses it may act as a poison, though it is very insoluble in water. It is, however, dissolved in considerable quantity in water which contains free carbonic acid.

Sugar of Lead (acetate of lead).—This substance is sold in the form either of a crystalline mass resembling lump sugar, or in that of a glistening, heavy, white powder. It is very soluble in water, has a slight odour of vinegar, and a sweetish astringent taste. When heated, it first dissolves in its water of crystallization, then gives off a part of its acid, chars, and is partly reduced to the metallic state. When heated in the mouth of a glass tube under the blowpipe, distinct globules of lead are formed. If boiled with dilute sulphuric acid, acetic acid is given off, which may be known by its odour. The powder is also blackened by sulphide of ammonium, and changed to a fine yellow colour by iodide of potassium and chromate of potash. In a state of solution, it gives the characteristic reactions of all the soluble salts of lead.

Goulard's Extract (subacetate of lead).—This is found in the shops in the form of a whitish or yellowish-white solution. It has an alkaline reaction, and is distinguished from a solution of the acetate by the copious precipitate of carbonate of lead, formed by transmitting a stream of carbonic acid gas through it. Goulard's extract is an active poison, and has more than once proved fatal.

Sulphate of Lead.—This is a heavy white powder, insoluble in water and in acids, and unchanged by heat. It is blackened by the sulphide of ammonium. If it is suspended in water, and sulphuretted hydrogen gas is transmitted through it, the black sulphuret of lead is formed, the sulphuric acid remaining in the supernatant liquor, in which it may be detected by the nitrate of baryta. This salt of lead, in consequence of its extreme insolubility, is stated not to be poisonous; but it is possible that if given in a very large dose, it would not be quite inactive.

Chloride of Lead.—This is in the form of a white powder, sparingly soluble in cold, but more soluble in hot water, soluble in dilute nitric acid, but insoluble in alcohol. It has a sweetish taste. At a heat below redness, it fuses into a semi-transparent horny mass (*plumbum*

corneum), but is volatilized by an intense heat. Its solution has the reactions of a salt of lead.

There is a yellow oxychloride of lead used as a pigment under the name of *mineral*, or *patent yellow*, and *Turner's yellow*. Like the chloride, it is fusible, and remains fixed when melted.

Nitrate of Lead.—This is found in the form of tetrahedral or octahedral crystals, soluble in water. Filtering paper dipped in the solution and dried, burns like touch paper. When heated in a glass tube, nitrous acid vapour is given off, and the yellow protoxide remains behind. The solution gives the characteristic reactions of a salt of lead.

Salts of Lead in Organic Liquids.—Add to the suspected liquid a little nitric acid; boil, and filter. Transmit sulphuretted hydrogen gas through the filtered liquid. If a salt of lead be present, a black precipitate will be formed.

If no precipitate falls when the liquid is treated in this manner, collect the solid matters remaining on the filter, incinerate, dissolve the ash in nitric acid, dilute and filter the resulting liquid, and transmit the sulphuretted hydrogen gas as before.

If by either or both of these processes a black precipitate is obtained, it may be proved to contain lead in either of two ways. 1. By placing the dried precipitate on a fragment of charcoal, and reducing the metal by the blowpipe. Or, 2, By exposing the sulphuret to a red heat in a tube open at both ends, to burn off the sulphur, treating the residue with strong nitric acid, and diluting the resulting solution with distilled water. The solution must then be filtered, evaporated to dryness, and gently heated to expel the excess of nitric acid. The residue, being dissolved in distilled water, will give the characteristic reactions of lead. Care must be taken in these experiments to avoid the use of ordinary flint glass, which always contains lead.

If no lead should be obtained by either of the foregoing methods, the stomach itself may be cut into fragments and incinerated.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—All the salts of lead, with the exception, perhaps, of the sulphate, act as weak irritant poisons, differing from the other irritants chiefly in the absence of diarrhœa, and the presence of the opposite state—constipation. Even the most soluble preparations of lead act feebly as compared with most of the metallic irritants, and rarely proved fatal.

The usual symptoms produced by a large dose of a soluble salt of lead are a burning and pricking pain in the throat and gullet, thirst, vomiting, colic pains, with tenderness of the belly, obstinate constipation, cramps in the extremities, cold sweats, and, in fatal cases, convulsions, and tetanic spasms. In one recorded case the pulse fell to 40.

The most important and interesting form of lead poisoning is that which is induced slowly by the long-continued use of preparations of

lead, whether as medicine, in the arts, or in consequence of the accidental impregnation of water or articles of food. The form in which the effects of the poison first show themselves is that of the painters' colic; its more remote effects are known as the lead palsy.

The Painters' Colic, or, as it is called from the place where it was first observed, *Colica Pictonum*, is marked by excruciating pain of the abdomen, especially in the pit of the stomach and around the navel. This pain is almost always relieved by pressure. The belly is hard, the muscles of the abdomen strongly contracted, and the navel drawn inwards. The bowels are either obstinately confined or scanty motions are passed with much suffering. Very rarely diarrhœa is present. The urine is small in quantity, and passed with difficulty. The countenance is dull and anxious, the skin bedewed with cold perspiration, the pulse commonly of the natural frequency, but sometimes accelerated, the breathing quick and catching. In rare instances febrile symptoms are present.

The painters' colic sometimes comes on without previous symptoms of diséase, at others after long-continued indigestion and disorder of the bowels. It may terminate either in complete recovery, or may pass into the second form of chronic poisoning—lead palsy. In rare instances it terminates in a species of apoplexy, which comes on with giddiness, extreme weakness, and torpor. As these symptoms increase, the pains in the belly subside, and the patient at length dies convulsed and comatose.

Lead Palsy.—This is sometimes the termination of a single attack of colic, but more commonly it supervenes after repeated seizures. In some cases, again, it comes on without any previous attacks of colic. The disease chiefly affects the upper extremities, especially the muscles of the hand and forearm, which first lose their power and then gradually waste away. The loss of power is chiefly in the extensor muscles, so that when the arm is raised, the hand falls by its own weight. Hence the expression, 'dropped hand.' The patient generally raises one hand by the aid of the opposite arm, which is very characteristic of the loss of power in the muscles of the forearm and hand.

This affection is in all cases difficult of cure, and very apt to recur on the renewed application of its cause. The persons most subject to the action of lead are those employed at furnaces for smelting lead ore, manufacturers of litharge, and of red and white lead, house-painters, colour-makers, plumbers and workers in lead, glass-blowers, glaziers, potters, and manufacturers of glazed cards. It occurs occasionally in persons who make comparatively little use of lead, as in compositors from the handling of the types, in fishmongers from the use of lead counters covered with brine.* In other cases, where it cannot be traced to the use of lead in any way, it is attributable to the drinking of water contained in leaden pipes or cisterns, under the circumstances presently to be mentioned.

* I have witnessed two or three cases among this class of tradesmen.

In the course of the several employments just mentioned, lead finds its way into the system either by the skin, the lungs, or the stomach.

The chief practical rule for the prevention of disease consists in the strict enforcement of cleanliness. A great amount of disease has been prevented by the substitution of moist for dry grinding.

Animals are frequently poisoned by lead contained in the water they drink, and sometimes by the use of utensils containing some preparation of lead.

There is one symptom which has been pointed out as characteristic of the action of lead on the system; viz., a blue line on the gums round the margin of the teeth. This is a valuable indication, and one rarely absent where marked symptoms of lead poisoning are present. It exists in many cases where it is not possible to prove the introduction of lead into the system, and when it is necessary to assume that it finds its way into the body through the water which the patient drinks.

Post-mortem Appearances.—In one case of acute poisoning by Goulard's extract, the morbid appearances were the following:—The lower end of the gullet, the whole stomach and duodenum, a part of the jejunum, and the ascending and transverse colon were greatly inflamed, and the villous coat of the stomach appeared as if it had been macerated. The stomach contained six ounces of a reddish-brown fluid which had a sweetish, styptic, metallic taste, exhaled the odour of vinegar while evaporating, and yielded globules of lead when the dry residue was subjected to the process of reduction. (Christison.)

In colica pictonum there are no constant morbid appearances beyond an unusual constriction of the large intestines. In lead palsy the affected muscles are found pale and flaccid, and when the disease has been of long continuance they resemble white fibrous tissue.

Treatment.—The antidotes to the salts of lead are the soluble alkaline or earthy sulphates—the sulphates of soda or magnesia. These should be freely administered, dissolved, or suspended in water. If vomiting is absent, it may be excited by emetics of sulphate of zinc, and encouraged by copious draughts of warm water, or the stomach-pump may be used. Milk and white of eggs may be given with advantage. When the colic pains are severe, and the bowels costive, opium may be administered in combination with aperients, and copious injections of warm water may be given. The remainder of the treatment is that proper to the irritant poisons.

In consequence of the extensive use of lead in pipes and cisterns for conveying and holding water, and the ill effects which sometimes result from the action of the water upon it, it is important to examine the circumstances under which that action takes place. This subject has been carefully examined by Drs. Christison, Taylor, and Miller. The principal results of their inquiries may be briefly stated as follows:—

The contact of air and water with the metal leads to the formation of an oxide of lead, which is dissolved in the water. The solution

absorbs carbonic acid from the air, and the resulting oxycarbonate is deposited in silky scales. A fresh portion of oxide is formed and dissolved and a fresh crop of crystals deposited; and in this way the metal is rapidly corroded. The free access of atmospheric air is essential to these changes, for distilled water deprived of its gases by boiling, and excluded from the air, has no action on lead. The action of air and water on lead is very rapid when the water is pure. Thus distilled water, or very soft water, or rain water collected in the open country left in contact with pure lead, with the free access of air, cause a very rapid corrosion of the metal; but the rain water collected from the roofs of houses in large towns, in consequence of the impurities which it dissolves, has little or no action on lead.

On the other hand, the action of water on lead is materially modified by the presence of various saline substances, even in the small quantity of three or four grains to the gallon. The chlorides and nitrates increase the corrosion; but the sulphates, phosphates, and carbonates lessen it. Bicarbonate of lime is a very effectual preservative, and to the presence of this substance many springs owe their property of not acting on lead. Sulphate of lime also affords a very complete protection, so small a quantity as one part in 5000 effectually preventing the formation of the carbonate. Some kinds of river water, as that of the Thames and the water used in Edinburgh, contain saline matters in sufficient proportion to render the use of lead perfectly safe. The same remark applies to most spring waters. But the waters of some rivers and springs are so destitute of saline matters as to act powerfully on lead. It must, moreover, never be forgotten that carbonic acid, if present in the water, will completely counteract the preservative effect of the salts above mentioned. It is better, therefore, to forego the use of lead for cisterns and water-pipes. Slate should be used for cisterns, and iron, earthenware, or glass for pipes.

It may be stated, then, as a general result, that the action of water on lead, and the consequent danger of conveying and preserving it in pipes or cisterns made of that material varies directly as the purity of the water. It follows that we may render the use of lead for such purposes perfectly safe by the artificial admixture of saline matter with the purer kinds of water. Sulphuric acid by forming an insoluble sulphate of lead is also an efficient protection. The use of lead is attended with most danger when it is employed to collect or preserve rain or snow-water, or spring water of unusual purity; and the danger is increased by the use of leaden lids to cisterns, the pure water rising by a natural process of distillation, and collecting on the lid.

There is one cause which greatly facilitates the action of water on lead, and which may act with sufficient energy to neutralize the preservative effects of saline matter, and be even increased by its presence, namely, the galvanic action excited by the contact of some other metal with the lead, or of the solder used for joining the sheets of lead.

The vegetable acids and fatty substances have the property of dis-

solving lead; hence the danger of keeping ascescent fruits, or liquors, or fatty matter, in vessels made of that material, or glazed with the oxide. Sour milk, cider, wine, and rum, have obtained poisonous properties in this way. Shot used for cleaning wine-bottles, and then carelessly left in them, have impregnated the wine with lead.

The treatment which seems best suited to promote the elimination of lead from the system consists in the administration of iodide of potassium in doses of five or of ten grains three times a day.

5. COPPER AND ITS PREPARATIONS

Poisoning with the salts of copper is of very rare occurrence. Among the 543 cases of poisoning occurring in England and Wales in 1837-8, not one was due to this cause, nor is the poison specified in the Registrar-General's list of the causes of violent death in the five years 1852-56. In consequence of the marked colour of all the salts of copper, they are not likely to be taken accidentally, and they are ill adapted to the purposes of the murderer. They are, however, occasionally used by the suicide. The use of copper utensils in cookery sometimes leads to the accidental admixture of poisonous salts of copper with food; and the sulphate of copper has been improperly employed to promote the fermentation of dough, to decolourize sugar, and to give a green colour to pickles. The arsenite or aceto-arsenite of copper is also largely used in the arts. See Arsenic (p. 397).

Metallic copper is not poisonous; but in consequence of the readiness with which it oxidates and combines with acids, it cannot be swallowed with impunity. Very injurious consequences have been known to be produced by sucking copper coin; and in a state of minute division, as used in the process of printing, it appears to act as a poison.

Copper in the form of hydrated oxide, and in combination with acids, is in common use in the arts. It will be necessary to particularize the following: the hydrated peroxide, the carbonate, the sulphate, and the acetates.

The Hydrated Peroxide.—Copper exists in this shape under the names of mineral green and verditer. Mineral green formerly consisted of arsenite of copper, but is now formed by a combination of the hydrated peroxide with pure lime or chalk, potash, and alumina. Verditer consists of the same materials in a different proportion.

The anhydrous peroxide of copper is a brownish black powder, which is readily dissolved by nitric acid, the solution assuming, on the addition of ammonia in excess, a deep blue colour. The *hydrated* peroxide of copper may be procured by adding liquor potassæ to a solution of any of the soluble salts of the metal.

As none of the salts of copper assume the importance of arsenious acid or corrosive sublimate, it will suffice to consider the tests for copper generally, and then to describe and distinguish from each other those salts which are in common use.

Tests for the Salts of Copper.—All the salts of copper are either

blue or green. Their colour, therefore, distinguishes them at once from most other substances. The salts of nickel and the sulphate of iron are also green, but the distinction between the green salts of copper and these substances will be readily made by comparing them in a state of solution. In very dilute solutions the colour of the salts of copper disappears, or is so masked as to afford no clue to the nature of the substance with which we have to deal: it will be necessary, therefore, to suppose that substance to be unknown to us. Acting on this supposition, we first test the liquid with sulphuretted hydrogen, when we obtain a deep brown or black precipitate. Sulphide of ammonium yields the same precipitate. On the addition of liquor ammoniæ the hydrated peroxide is first thrown down; and this being dissolved, by the addition of ammonia in excess, the characteristic deep blue coloured solution of the hydrated peroxide is formed.

The salts of copper in solution may be further identified by the following tests: 1. Ferrocyanide of potassium yields a fine hair-brown gelatinous precipitate; 2. Polished iron (a knife or a needle suspended by a thread) placed in a solution of a salt of copper is speedily coated with a thin film of the metal; 3. A drop of the solution placed on platinum foil, and slightly acidulated, when touched with a strip of zinc, yields a similar metallic deposit; 4. If a minute fragment of zinc is placed in a drop of a solution of a salt of copper on a flat surface of glass, the copper is deposited in an arborescent form; and is sufficiently distinguished from other metals by its colour.

Some of the salts of copper possess peculiar properties, and may have to be distinguished from each other.

Carbonate of Copper (natural verdigris).—This is the greenish coating formed on the surface of copper and its alloys by the action of air and water. It is readily distinguished from the other salts of copper by effervescing with acids. The reactions of the base are those of other salts of copper.

Sulphate of Copper (blue vitriol, blue-stone, Roman vitriol).—The base is detected by the tests already described. The salt is further known by adding a few drops of liquor ammoniæ, and a solution of arsenious acid. Green arsenite of copper is thrown down. The sulphuric acid in combination may be detected by the test of nitric acid and nitrate of baryta.

Subacetate of Copper (artificial verdigris).—The term artificial verdigris is sometimes applied to the unmixed subacetate, and sometimes to a combination of this with the neutral acetate and carbonate. Its colour accordingly varies, being sometimes blue and sometimes green. The subacetate is known by the effect of heat. When introduced into a test tube, and heated by the flame of a spirit lamp, a portion of acetic acid is given off; and another part being decomposed, leaves an ash of carbon, which deoxidizes the copper, so that a thin film of metal is left on the sides of the tube.

Acetic acid is also given off on boiling the salt with dilute sulphuric acid.

Nitrate of Copper.—This is in the form of deliquescent blue crystals. The acid in combination may be detected by the absence of a precipitate with nitrate of baryta, and with nitrate of silver; and by the ruddy fumes of nitrous acid gas evolved by boiling the crystals with tin filings in a few drops of distilled water. By adding liquor potassæ to the solution, nitrate of potash is formed, which may be identified by appropriate tests (p. 333).

Chloride of Copper.—There is a soluble chloride, and an insoluble subchloride of copper. The chloride is of a bright-green colour, the subchloride is white. An oxychloride is known in the shops as Brunswick Green.

The *chloride* is deliquescent and very soluble in water; the subchloride is insoluble in water, but soluble in acids. The tests for the base are the same as for other salts of copper. The hydrochloric acid in combination may be detected, in the case of the soluble chloride, by the addition of nitrate of silver. The insoluble subchloride must be converted into a soluble salt for the purposes of examination.

Arsenite of Copper.—See the chapter on Arsenic (p. 397).

The several salts of copper are found in the shops, mixed in various proportions and under different names, as pigments.

Copper in Organic Liquids.—Solutions of copper are decomposed by several of the common contents of the stomach,—such as albumen, fibrin, milk, tea, coffee, &c., and by the mucous membrane of the stomach, the suboxide being thrown down. As the salt of copper is not always completely decomposed, it may often be obtained in sufficient quantity for analysis by simply boiling with distilled water and passing the solution through a filter. The insoluble substances must be reserved for further examination. The clear liquid which has passed the filter may be tested by the reagents just described. By slightly acidulating the liquid, and then passing through it a stream of sulphuretted hydrogen, the brownish-black sulphuret of copper is thrown down. This must be carefully collected, and washed, and incinerated in a glass tube. It is thus freed from any adhering organic matter. The sulphuret may now be converted into sulphate by treating it with a few drops of nitric acid. The solution will strike the usual deep blue colour with an excess of ammonia.

If copper is not by this means detected in the liquid which has passed the filter, the insoluble substances which remain on the filter, or are contained in the stomach, must be dried and heated to redness in a crucible, till they are completely charred. The residue contains metallic copper, and must be gently heated in equal parts of nitric acid and water. Nitrate of copper is thus formed, which may be identified by the usual tests.

Copper has been detected in the solid organs of the body, but more rarely in the secretions, in cases of poisoning by its salts.

Copper has also been found in several vegetable substances used as food, and is asserted to exist as a natural constituent of the fluids and solids of the human body. The existence of copper in vegetable substances has been confirmed and explained by M. Boutigny, who has traced it to the manure used in raising those substances. Its presence as a natural constituent of the human body, has, however, been rendered doubtful by the negative results of experiments performed by Christison and Chevreul. The quantity of copper existing naturally in animal and vegetable substances is so minute, not exceeding in any case one part in 120,000, and in some instances being so little as one in 1,500,000 parts, that it can give rise to no fallacy even where large portions of the solid contents of the stomach or of the body itself are submitted to analysis.

Quantitative Analysis.—Use for this purpose the precipitated sulphuret, digest it in nitric acid, and precipitate the oxide from the solution by potash. One hundred parts of the black oxide correspond to 312 of the crystallized sulphate.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms set in from a quarter to half an hour after swallowing the poison, with pains in the abdomen resembling colic, with nausea, eructations, vomiting of matters of a bluish or green colour, purging and cramps in the extremities. Nervous symptoms also supervene. Convulsions, palsy of the limbs, tetanus, and insensibility have been present in different cases. As in the case of arsenic and mercury, the group of symptoms varies in each instance. One symptom of more frequent occurrence in poisoning with the salts of copper than in poisoning with other irritants is jaundice.

Post-mortem Appearances.—The mucous membrane of the stomach and intestines has been found inflamed, ulcerated, thickened, and of a green colour, and in parts apparently gangrenous. The salt of copper sometimes adheres to the surface of the membrane. The inflammation and discolouration of the mucous membrane occasionally extend to the œsophagus. The skin is yellow. The other post-mortem appearances are not characteristic.

In some instances the intestines have been found perforated.

Treatment.—The antidotes to the salts of copper are albumen, and iron filings. The first is to be preferred. The treatment will consist in the free administration of the white of egg, followed by mucilaginous drinks. If vomiting is not present the stomach-pump may be used. The remainder of the treatment will vary with the symptoms.

Severe effects have been produced by comparatively small doses of the salts of copper. In a case mentioned by Dr. Percival, convulsions were occasioned by two drachms of blue vitriol.

Shortest Fatal Period.—The salts of copper have proved speedily fatal. A girl aged sixteen months died in *four* hours after swallowing

several fragments of blue stone (Taylor). In other instances death has taken place after longer intervals, such as 12, 13, 60, 72, and 78 hours.

Accidental Poisoning by Copper.—Serious and even fatal accidents have occurred from the use of copper vessels in cooking.

The inmates of a monastery suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness, flatus, burning pain in the pit of the stomach, in the kidneys and extremities, and paralytic weakness in the arms. These symptoms were traced by Gmelin to the fact, "that every vessel in the kitchen, the pots and pans, and even the milk pails and butter dishes for storing the butter, were made of copper."

The principal facts established in reference to the impregnation of various fluids and articles of food with copper, in consequence of being prepared or kept in copper vessels, are the following. Distilled water kept in contact with clean copper is not impregnated with it. Solutions of several saline matters, as common salt, alum, nitre, and Epsom salts, when heated in copper vessels, are found to contain the poison. Acids, and fatty and oily matters, especially when rancid, act still more strongly on copper vessels. One general principle applies to all these substances, which is, that provided the vessels be clean, they may be boiled in them with comparative safety, but cannot be allowed to stand in them without danger. The contact of air with the moistened copper leads to the formation of the hydrated carbonate, which is dissolved by any acid that the substance may happen to contain. As saline, acid, or oily matters act strongly on copper vessels, it would be well to avoid using such vessels in preparing articles of food containing any of these matters.

6. ZINC, TIN, SILVER, IRON, BISMUTH, CHROME, AND THEIR PREPARATIONS.

There are two preparations of zinc which require notice—the sulphate and the chloride.

ZINC (sulphate of zinc, white vitriol, white copperas).—This substance is in common use as an emetic, but as a poison it is unimportant.

Sulphate of zinc is found in the form of colourless, or nearly colourless, prismatic crystals, of a styptic taste, and very soluble in water. It resembles oxalic acid and sulphate of magnesia. From the former, it is distinguished by the tests described at p. 345, and from the latter by adding to their respective solutions sulphuretted hydrogen or sulphide of ammonium. The sulphate of zinc yields a white precipitate, but there is no precipitate with the sulphate of magnesia.

Sulphate of zinc in solution possesses the following properties: 1. It is precipitated as a white sulphuret, by sulphuretted hydrogen and sulphide of ammonium, provided the solution does not contain an excess of acid. 2. Liquor ammoniæ and the sesquicarbonate of ammonia throw down a white precipitate soluble in an excess of the precipitant. 3. Ferrocyanide of potassium causes a white precipitate.

As sulphate of zinc often contains iron, the precipitates are apt to be tinged with the colours which iron gives with these reagents.

In Organic Liquids.—Sulphate of zinc is decomposed by albumen and milk, which form with the oxide an insoluble compound, and also by substances containing tannin. The first step of the process for organic liquids consists in acidulating with acetic acid, by which any oxide thrown down in union with animal matters is dissolved. The mixture must then be filtered, and sulphide of ammonium added. A white sulphuret of zinc is thrown down, which must be washed, collected, dried, and heated to redness in a glass tube. The residue is then to be acted on by strong nitric acid, which dissolves the zinc; and the acid solution, being neutralized by carbonate of ammonia, is ready for the application of the tests. The carbonate of zinc which results from this decomposition becomes yellow when heated, and resumes its white colour on cooling. It is also redissolved by an excess of the carbonate of ammonia.

Symptoms.—Sulphate of zinc is one of the simplest of the irritant poisons. It has a disagreeable bitter taste, and causes, in large doses, dryness of the throat, thirst, vomiting, purging, and pain of the abdomen. In consequence of its strong emetic properties, it is, in most cases, soon rejected from the stomach; but in a case reported by Dr. Gibb, in which 67 grains, contained in a lotion, was swallowed by an adult female, there was no vomiting from the poison, and some difficulty in relieving the stomach by emetics. It has been administered medicinally in doses of two scruples three times a day for several weeks, without injurious consequences. (Dr. Babington.)

The Post-mortem Appearances are those of simple inflammation of the mucous membrane of the stomach and intestines.

Treatment.—This consists in the use of a dilute solution of carbonate of potash as an antidote, followed by the free administration of milk, of the white of egg in large quantity, and of liquids containing tannin, such as tea, and decoctions of oak or Peruvian bark. The remainder of the treatment is that common to all the irritant poisons.

Chloride of Zinc.—An aqueous solution of this substance is the disinfectant known as "Burnett's Fluid." It is a corrosive poison, and produces the symptoms and post-mortem appearances common to the class of corrosive poisons; and it requires the same treatment. (See Irritant Poisons, p. 317.)

TIN.—*Chlorides of Tin.* There are two chlorides of tin, the protochloride and the perchloride. A mixture of these two salts in solution is known by the name of *dyers' spirit.* They also exist in the form of yellowish-white acicular crystals. These are the only preparations of tin which require notice.

Tests.—The *protochloride* has the following properties: 1. Sulphuretted hydrogen or sulphide of ammonium throws down a precipitate of a dark chocolate colour, soluble in an excess of sulphide of ammonium. 2. The bichloride of mercury gives a grey

precipitate of finely divided mercury. 3. Chloride of gold gives a deep purple precipitate (the purple of Cassius). 4. A fragment of zinc placed in a drop of the solution throws down the metal in an arborescent form, characterized, though not distinguished, by the rectangular arrangements of the branches (fig. 50). One grain of the protochloride in two ounces of distilled water gives characteristic results. These are the tests for the base. The acid is detected by the white precipitate insoluble in nitric acid, thrown down by nitrate of silver.

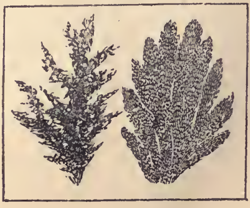
Fig 50.

The *perchloride* is precipitated yellow by sulphuretted hydrogen, and sulphide of ammonium, the precipitate being soluble in an excess of the sulphide. In colour, therefore, the precipitated sulphide resembles the sulphide of arsenic and the sulphide of cadmium. It differs from the former in being insoluble in ammonia, and from the latter in being insoluble in hydrochloric acid. Neither corrosive sublimate nor the chloride of gold gives any precipitate with the perchloride. The acid of the salt may be detected by the nitrate of silver.

The salts of tin produce the common symptoms of irritant poisoning, which must be met by the free use of albumen or milk, and of diluents. Emetics, or the stomach-pump may be employed if necessary.

SILVER.—*Nitrate of Silver*—(Lunar Caustic). This substance is met with in the form of tabular crystals, or fused into small cylinders. It has the following properties :—It is very soluble in distilled water. Its solution has an acid reaction, and a strong styptic, metallic taste; is a very powerful corrosive; and, when mixed with organic matter, is blackened by light. The base is detected by the following tests :—1. Sulphuretted hydrogen or sulphide of ammonium yields a black precipitate. 2. Liquor ammoniæ throws down the brown oxide, which is dissolved by the precipitant in excess. 3. Hydrochloric acid yields a white clotted precipitate, the chloride of silver, which is insoluble in nitric acid, and when heated on platinum foil fuses into a horny mass. 4. On adding to the solution liquor ammoniæ, until the brown oxide is redissolved, and then arsenious acid, the yellow arsenite of silver is thrown down. 5. A strip of copper introduced into the solution is speedily coated with silver. 6. If a minute fragment of zinc is placed in a drop of the solution the metallic silver is deposited in an arborescent form (fig. 51). This test is very delicate, a distinct tree (generally in the shape of the shaded figure) being

Fig. 51.



obtained from a grain of nitrate of silver in eight ounces of water. The acid is detected by adding to the filtered liquid, remaining after the application of the tests, carbonate of potash, when nitrate of potash is formed.

No detailed cases of poisoning by nitrate of silver have been placed on record, but from experiments on animals, it appears that it acts as a simple corrosive and local irritant.

The *treatment* consists in changing the soluble nitrate of silver to the insoluble chloride, by the free use of a solution of common salt.

IRON.—The sulphate of iron (green vitriol, copperas) and the chloride, or muriate, of iron possess sufficiently active properties to entitle them to the name of poisons, but they are among the least active of the irritants. The base may be detected by the following tests:—1. Sulphuretted hydrogen gives no precipitate, but the sulphide of ammonium throws down a black sulphide. 2. Infusion of galls also gives a black precipitate. 3. Ferrocyanide of potassium throws down a blue precipitate, which deepens by exposure to the air. 4. Sulphocyanide of potassium gives a deep blood-red precipitate. The acid in combination in the sulphate and muriate, respectively, may be detected by the nitrate of baryta and nitrate of silver.

The *sulphate of iron*, and the *chloride* in the form of tincture, have both proved fatal, and have in one or two other instances produced severe effects. The symptoms and post-mortem appearances in one case of poisoning by the tincture, recorded by Dr. Christison, were those of a strong irritant. The treatment would consist in the free use of emetics and diluents.

BISMUTH.—*Trisnitrate, subnitrate, or nitrate of Bismuth.*—This substance has proved fatal in a large dose, with the symptoms and post-mortem appearances proper to irritant poisoning. It is found in the form of a white, insoluble powder, which is blackened by sulphuretted hydrogen, and sulphide of ammonium. It is soluble in nitric acid, but it is again thrown down when the solution is largely diluted with water. The solution resembles that of the salts of lead in being precipitated white by liquor ammoniæ and liquor potassæ, but differs from it inasmuch as it gives no precipitate with dilute sulphuric acid. It gives a deep-brown precipitate with iodide of potassium.

CHROME.—The *bichromate of potash* is much used as a dye. It is found in the form of deep orange-red crystals, which yield a yellow solution. The solution has an acid reaction. With the salts of lead it gives a yellow, and with those of silver a deep-red precipitate. Little is known of the action of this substance on man, but experiments on animals have shown that it possesses the properties of an irritant poison. The treatment would not differ from that proper to the class of irritants.

CHAPTER XII.

NARCOTIC POISONS.

This class of poisons owes its importance less to the number of individual poisonous substances which it comprises (for they are few) than to the habitual use made of them by large classes of persons, their constant employment in the treatment of medical and surgical maladies, the many accidents to which they give rise, and the many occasions on which they are employed by the suicide or murderer. For all these reasons combined poisons belonging to this class are used twice as often as the whole class of irritants, and more than fifty times as often as the whole class of narcotico-acrids.

The narcotic poisons are characterized by the disorder which they produce in the functions of the brain and spinal cord. In one leading division of the class, comprising opium and its preparations, symptoms of narcotism are the most prominent. In the other, which comprises prussic acid and the substances that contain it, narcotic symptoms are less conspicuous, and are subordinate to the effect produced on the functions of the heart and lungs.

In examining this class of poisons we encounter difficulties which do not occur in the case of the class of irritants. The symptoms they produce are more apt to simulate those of disease, and the post-mortem appearances are often very slight and indistinct. The chemical analysis, moreover, is, on the whole, less sure and satisfactory.

The *symptoms* of narcotic poisoning are giddiness, headache, dimness of sight, noises in the ears, drowsiness and confusion of mind, passing into insensibility more or less complete. Delirium is rare, and palsy, convulsions, and tetanic spasms are only of occasional occurrence.

The *morbid appearances* are often slightly marked. They consist in fulness of the veins and sinuses of the brain, with effusion of serum beneath the membranes, at the base, and into the ventricles; and in some instances extravasation of blood.

The *treatment* of cases of poisoning by the narcotics as a class does not admit of being laid down with precision. The use of the stomach-pump, or of emetics, to discharge the poison; the cold affusion to rouse the patient; forced exercise to prevent sleep; stimulants to restore the patient from collapse; warmth and frictions in case of apnœa; and in extreme cases, artificial respiration, and the galvanic shock, are the items of treatment common to the whole class.

The narcotic poisons as a class are distinguished from the narcotico-acrids as a class by the absence of irritation of the stomach and bowels. When irritation of any part of the alimentary canal exists, it assumes the form of nausea and vomiting, which occur, not at the commence-

ment, as in the case of the irritants and narcotico-acrids, but when the patient begins to recover from the effects of the poison. Diarrhœa is a rare incident in narcotic poisoning; but the expulsion of the contents of the bowels often occurs in poisoning by prussic acid as in other violent and sudden deaths.

Among the narcotic poisons it is possible to distinguish three classes: —a class, to which opium and its preparations, and the narcotic gases belong, characterized by the production of narcotism either without a previous stage of excitement, or with that stage faintly marked; a class to which alcohol and the æthers belong, characterized, though not always, yet often, by a preliminary stage of excitement; and a class, of which prussic acid and the substances containing it are the only members, which, in fatal doses, kill by syncope or shock, and in smaller doses occasion narcotism and a state resembling apnœa.

There are several diseases affecting the brain and nervous system, which, in the symptoms they present during life, and the morbid appearances they leave after death, resemble more or less closely the operation of one or other of these three classes of narcotic poisons. Diseases of the heart and large vessels may destroy life suddenly or speedily with symptoms not unlike those of poisoning by a full dose of prussic acid; and a person may die in an epileptic fit with some symptoms common to it and to poisoning by the same substance. On the other hand, all the poisons of this class which do not prove rapidly fatal, and prussic acid itself in smaller doses, develop symptoms of narcotism which are also present in attacks of apoplexy and of uræmia. Again, many chronic diseases of the brain and spinal cord, and many affections of the nervous system, terminate fatally after decided symptoms of narcotism. It must also be borne in mind that, in infancy and childhood, convulsions from teething or from gastric or intestinal irritation, as well as narcotism from the state of brain preceding and accompanying the effusion of serum, are of very common occurrence. It may, therefore, sometimes happen that we are called upon to distinguish certain diseases and their symptoms from the effects of narcotic poisons.

This distinction between disease and narcotic poisoning must often present difficulties in infants and young children, and occasionally in adults. But we are sometimes greatly assisted by detecting the peculiar odour of the poison, and, in the case of prussic acid and oil of bitter almonds, by finding the vessel from which the poison has been taken on the person or near the body. In other instances, the death is fully explained on the examination of the dead body, by the discovery of organic disease of the heart and large vessels, or of the brain, or of some disease of the kidney capable of giving rise to the poisoned state of the blood known as uræmia. Among the diseases of the heart which may occasion sudden or speedy death it is important to include fatty degeneration of the substance of the organ which is now admitted among the recognized causes of such deaths. Effusion of serum or of blood

upon the brain or into any part of the cavity of the cranium would not be conclusive evidence of death by disease, as such appearances have been present in one or two cases of narcotic poisoning in healthy subjects.

In some cases the interval which has elapsed between the presumed administration of poison and the first appearance of the symptoms, is such as of itself to rebut the supposition of poisoning. But this means of distinction will be best considered when treating of the narcotic poisons individually.

Among the fatal diseases to which reference has just been made, there are two of such common occurrence that it may be well to specify some of the best-ascertained facts respecting them for use in cases of difficult diagnosis.

Apoplexy.—Apoplexy is sometimes preceded by marked premonitory symptoms of long continuance. It is rare under thirty years of age, while many cases of poisoning by narcotics occur in infants and young persons. Apoplexy sometimes follows directly upon a full meal; in other instances on sudden exertion or violent passion. The symptoms of apoplexy manifest themselves suddenly. In many cases of apoplexy there is rather a loss of power to move and to articulate than a loss of the intellectual faculties. In cases of narcotic poisoning, the mind is evidently more strongly affected; the stupor is more complete, but the loss of power much less marked. In the former case, the muscles are paralysed, in the latter, the will. When, however, the apoplectic patient is insensible, he is more difficult to rouse than one who has taken narcotic poison. Narcotic poisons, when they prove fatal, destroy life much more rapidly than most apoplectic attacks. On the other hand, when apoplexy destroys life very rapidly, it does so sooner than any other poison of the narcotic class, except hydrocyanic acid or the narcotic gases.

The *post-mortem appearances* in cases of apoplexy generally differ from those due to poison. Effusion of blood on the surface, in the ventricles, in the substance, or at the base, of the brain, is rare in poisoning, so that its presence affords a strong presumption in favour of sanguineous apoplexy. A copious effusion of serum in the same situation affords a less forcible presumption in favour of serous apoplexy; while a mere turgescence of the veins and sinuses of the brain furnishes in itself an equal presumption in favour of poisoning or of simple apoplexy.

Epilepsy.—Epilepsy is one of the occasional symptoms of irritant poisoning, and of poisoning by the narcotico-acrids. It also resembles acute poisoning by prussic acid. When it is merely one of a group of symptoms due to poisoning, the concomitants will serve to distinguish it at once from a case of simple epilepsy. The points of distinction most insisted upon are the following: The epileptic fit almost always begins abruptly, and in most cases without any previous warning; and the premonitory symptom, if present, is rarely such as to be con-

founded with the effects of a narcotic poison. The symptoms of narcotic poisoning, also, gradually increase in severity. In epilepsy the patient cannot be roused by external stimuli. The reverse obtains in most cases of narcotic poisoning. In fatal cases of epilepsy, death does not take place so rapidly as in poisoning by prussic acid, and generally after a longer interval than in poisoning with opium. Epilepsy very rarely, if ever, proves fatal in the first paroxysm.

Prussic acid, the poison which produces the symptoms most resembling epilepsy, would be at once detected by its odour. In fatal cases, the morbid appearances render little assistance to the diagnosis. There are no morbid appearances proper to epilepsy, but the brain is often found extensively diseased. If that disease is of a very marked character, it renders the supposition of poisoning improbable; but if it consist simply in congestion, or in a moderate effusion of serum, it is consistent with the supposition of poisoning, apoplexy, or epilepsy.

If death take place with symptoms similar to those of narcotic poisoning within the time at which such poisons may prove fatal, recourse must be had to the post-mortem appearances. These will often be of so marked a character as to explain the death without having recourse to the supposition of poisoning. But if the post-mortem appearances should happen to be such as are found in cases of poisoning, recourse must be had to an analysis of the contents of the stomach, which may issue in rendering the previous exhibition of poison improbable, or in proving that this was the cause of death.

The most important of the narcotic poisons are opium and hydrocyanic acid. Alcohol, ether, and chloroform follow next in order, and a feeble narcotic poison, lactuca, completes the list of simple narcotics.

The principal narcotic gases are, carbonic acid, carbonic oxide, and sulphuretted and carburetted hydrogen.

Some poisons usually classed with the narcotics will be considered as narcotico-acrids.

The relative importance of the two principal poisons of the narcotic class—opium and prussic acid—is shown by the fact that, on the average of the five years 1852 to 1856, opium and its preparations were administered in 141, and prussic acid and its preparations in 34, cases of poisoning, in which the nature of the poison was distinctly specified.

CHAPTER XIII.

OPIUM AND ITS PREPARATIONS.

THE importance of opium and its preparations as poisons will be understood from the statement, that of the 543 cases of poisoning brought under the notice of the Coroner's court in England and Wales, during 1837-38, no less than 200 were cases of poisoning by opium or its preparations, either alone or in union with other poisons. This number exceeds the total of cases (184) of poisoning by arsenic.

Of these 200 cases, 42 were by solid opium, 133 by laudanum, 21 by other preparations containing opium, 2 by acetate of morphia, and 2 were cases of mixed poisoning (laudanum and prussic acid, and laudanum and aquafortis). Of the 200 cases, 64 occurred in children, and the remainder in adults, and of these 64, 41, or a fifth of all the cases, were from over doses of cordials or medicines, administered to infants and young children by their mothers or nurses.

Since the years 1837-38 great changes have taken place in the comparative frequency with which the different poisons are employed. In consequence partly of the legal enactment restricting the sale of arsenic, and partly of the increased knowledge of the properties of other poisons, opium and its preparations, which in 1837-38 formed four in eleven of all the recorded poisons, constitute on the average of the five years 1852-56 more than one-half of the deaths by ascertained poisons. The total annual average of deaths by ascertained poisons being 268, no less than 141 were attributed to opium and its several preparations, while prussic acid and its compounds accounted for 34 deaths, and arsenic and its preparations for only 27 deaths.

Opium itself caused, on the average of these five years, 34 deaths, laudanum 89, Godfrey's cordial 16, and morphia 2.

The cases of poisoning by opium and its preparations, in the five years, 1852-56, in which the ages of the victims were ascertained, amounted to 377; of which number 170, or nearly half, occurred in infants under one year of age, and 203 in children under five years old.

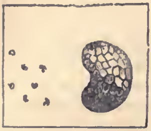
In adults the great majority of cases were suicidal. Only one murder and one manslaughter (by laudanum) are reported in the whole five years.

Opium and its preparations, especially laudanum, are sometimes given to facilitate the commission of other crimes, such as theft and rape. In such cases the taste and colour are generally concealed in brandy or coffee, and the poison is given after the sense of taste has been deadened by intoxicating liquors.

The *capsules* of the Papaver somniferum (white, or garden poppy)

furnish several preparations to the London Pharmacopœia—a decoction for external use, a syrup given chiefly to infants, and an aqueous extract (extractum papaveris), in addition to the inspissated juice known as opium. A decoction of the capsules, or poppy heads, not authorized by the Pharmacopœia, is sometimes given to infants with fatal effect. As the seeds from the capsule have been found in the stomach, and as the seeds taken by themselves have proved fatal in some instances abroad, the annexed wood-cut is given to show their size and microscopic character. They weigh about 230 to the grain. Some of the seeds are white, others grey.

Fig. 52



Opium, the inspissated juice of the unripe capsules, has the following familiar properties: It is of a reddish-brown colour, of a strong and peculiar odour, and a bitter and rather acrid taste. Different specimens of the drug vary in physical properties, and in activity, with the place of growth, the maturity of the capsule, the greater or less care bestowed on the manufacture, and the presence or absence of adulteration. The quantity of morphia may vary from 2 to 28 per cent. and the quantity of meconic acid bears no fixed proportion to the morphia which it holds dissolved. The average quantity of morphia in good Turkey opium is about 10 per cent., and the meconic acid is usually stated at 6 per cent. The drug consists of a number of distinct principles combined with a peculiar acid, and mixed with resin, and extractive matter. These principles are dissolved by water at ordinary temperatures, by alcohol, and by mineral and vegetable acids.

The preparations of opium in the London Pharmacopœia are:—The tincture, or *Laudanum*, which contains one grain in thirteen drops; the compound tincture of camphor, or *Paregoric*, which contains one grain in the half ounce; the extract of opium, a preparation of somewhat variable strength; the confection, which contains one grain in thirty-six; the compound ipecacuanha, or Dover's powder, which contains one grain in ten; the compound opium and chalk powder, which contains one grain in forty; and the compound kino powder, which contains one grain in twenty; the compound soap pill and compound styrax pill, which contain one grain in five. The vinum opii, frequently dropped into the eye, the enema opii, consisting of thirty drops of the tincture in ℥iv of starch, the emplastrum opii, the unguentum opii, and the unguentum Gallæ compositum, complete the long list of pharmacopœial preparations containing opium.

The *black drop* said to contain two, three, or four times as much opium as the tincture, and Battley's liquor opii sedativus, of which twenty drops are said to be equal to thirty of laudanum, are also in common use. The first is made with verjuice and aromatics, the second is believed to be an aqueous solution. Godfrey's cordial, Dalby's carminative, children's quietness, and several mixtures improperly given to children to procure sleep, contain laudanum as their chief ingredient

in combination with syrups, stomachics, and magnesia. The quantity of laudanum in these preparations is very variable.

Opium contains several active principles. Morphia, narcotine, narceine, meconine, thebain or paramorphia, codeia, papaverine, and meconic acid, have been separated; but the most important, indeed the only ones of any medico-legal importance, are *morphia* and *meconic acid*, which exist in combination in opium as a *meconate of morphia.* Opium may be recognized by the reactions of these two substances, as well as by its odour and other physical properties.

The morphia and meconic acid are extracted and separated by the following process:

The opium is infused in successive portions of cold water. This aqueous solution, which holds the active principles of the drug dissolved, is boiled with magnesia, in combination with which the active principles are thrown down. The precipitate thus formed, after being washed and dried, is boiled with proof spirit, which dissolves the narcotine and the resin, leaving the morphia and a meconate of magnesia behind.

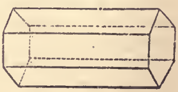
To separate the *morphia* from the meconate of magnesia the precipitate is boiled in strong alcohol, which dissolves the morphia mixed with some resin. From this impure spirituous solution, the morphia may be obtained pure by crystallization or by digesting it with animal charcoal.

To obtain the *meconic acid,* the impure meconate of magnesia is boiled in dilute sulphuric acid, and the mixture partially evaporated. The sediment which falls on cooling is dissolved in water, and acetate of lead is added to the solution. A meconate of lead is thus formed. This is washed and suspended in water, and a stream of sulphuretted hydrogen gas is transmitted through it. Sulphuret of lead is thrown down, and meconic acid left in solution; and on evaporation, impure scaly crystals of meconic acid are obtained.

TESTS FOR MORPHIA AND MECONIC ACID.

MORPHIA.—*Properties*:—1. It is sold as a white powder, or as crystals, which when quite pure are colourless; but they are generally more or less discoloured by resin. Their form is the six-sided prism (fig. 53). Crystals, or the fragments of crystals of this shape may be recognized in good specimens of the alkaloid. 2. They have a bitter taste, but no odour. 3. When heated, they first melt into a yellow oily liquid, then burn like a resin, leaving a carbonaceous deposit of a semi-crystalline appearance, and giving out ammonia. 4. They are very sparingly soluble in cold water, sparingly soluble in hot water, more soluble in æther, and still more so in alcohol. They are soluble in the caustic alkalis, and very soluble in the mineral and vegetable acids, in combination with which they are used in

Fig. 53.



medicine. 5. In solution they have a slight alkaline reaction. 6. In common with other alkaloids, morphia is precipitated from its solutions by tann'c acid, biniodide of potassium, and corrosive sublimate.

Tests.—1. *Nitric Acid*, 2. The *Permuriate of Iron*, 3. *Iodic Acid and Starch*, 4. *Sulphuric Acid*, and *Bichromate of Potash.*

When these tests are applied to morphia, or to its salts, in substance, a white surface of porcelain should be used, and the reagents applied in quantities proportioned to the substance tested.

1. *Nitric Acid.*—When morphia is treated with nitric acid, it becomes instantly orange-red, and is dissolved with effervescence, nitrous acid fumes being given off. On standing, or on the addition of a larger quantity of acid, the colour of the solution changes to a bright yellow; and on heating it, it becomes of a straw colour. Nitric acid causes the same change of colour in moderately strong solutions of morphia.

2. *Permuriate of Iron.*—This test added to the crystals, or to a solution of morphia, or to morphia suspended in water, strikes a rich indigo-blue colour, turning to green when added in excess. The test should be neutral. It should not be applied to a hot or acid solution. If the test, or the solution, has an acid reaction, it should be neutralized by caustic potash.

3. *Iodic Acid and Starch.*—Morphia, when added to iodic acid, combines with its oxygen, and sets the iodine free, which may be detected by its brown colour, and the deep blue which it strikes with starch.

The iodic acid must not contain free iodine; nor must it be applied to an acid or hot solution. This is a very characteristic and delicate test, but liable to be interfered with by slight causes, and requiring time for the complete development of its effect.

4. *Sulphuric Acid and Bichromate of Potash.*—Strong sulphuric acid added to morphia in substance either produces no effect, or gives it a straw-tint; but on adding a solution of bichromate of potash, the mixture assumes first a rich brown tint and then rapidly changes to a green colour, due to the formation of the oxide of chrome.

When these four tests for morphia act characteristically on a white powder or colourless crystal, or on a colourless solution of a white powder or crystalline substance, there can be no doubt of the existence of morphia.

Meconic Acid.—This acid assumes the form of scaly crystals, which when impure are dusky red, when pure of a pale yellow colour, when quite pure almost colourless. They are soluble in cold water, and more soluble in hot water, the resulting solution having a strong acid reaction. When heated in a glass tube the crystals are partly decomposed and partly sublimed, and the sublimate condenses on the sides of the tube in the form of filamentous radiated crystals. Meconic acid is precipitated from its solutions by acetate of lead, as a meconate of lead,

which is insoluble in acetic acid. The only test of any value for meconic acid, whether in crystals or in solution, is one which has been just mentioned as a test for morphia, viz.:

Permuriate of Iron.—This reagent strikes with meconic acid an intense cherry-red colour, which is discharged by a solution of the protochloride of tin, but not by the dilute mineral acids, or by the solutions of bichloride of mercury and chloride of gold.

The test gives a similar reaction with the sulpho-cyanide of potassium, with the saliva which contains that salt, with common mustard in solution, and with the alkaline acetates; but this fact does not constitute an objection to the test for meconic acid obtained from a solution of opium, or from an organic fluid by the process now to be described.

If the tests for morphia and meconic acid act characteristically, the evidence of the existence of opium in the liquid from which they were obtained is conclusive.

Opium in Organic Mixtures.—In consequence of the important corroboration which the detection of meconic acid affords to that of morphia the process for organic mixtures should be one which separates both the alkaloid and the acid. A solution of opium itself may be regarded as a suspension of its active principles in an organic mixture, for opium, in addition to those principles, contains a large amount of resin and extractive matters. The process for the detection of the morphia and meconic acid in the contents of the stomach is as follows: The solid matters, if any, must be cut into small fragments, and well mixed with the more liquid contents, distilled water being added if necessary. The mixture must then be slightly acidulated with acetic acid, and after being allowed to stand for several hours must be filtered, evaporated to the consistence of a syrup, and treated with a solution of acetate of lead, so long as any precipitate falls. The liquid must then be boiled and filtered. An impure meconate of lead remains on the filter, while the fluid part contains the morphia. This impure meconate of lead must now be suspended in distilled water, and sulphuretted hydrogen must be transmitted through it. A sulphuret of lead is formed, and meconic acid remains in solution. This solution may be concentrated by evaporation, and the acid may be obtained in a state of greater purity by repeating the process. The fluid part which contains the morphia is next to be treated with sulphuretted hydrogen gas, by which any lead it may contain is thrown down as a sulphuret. The liquid must again be filtered, and on being reduced by evaporation to the consistence of a syrup, and treated with alcohol, the acetate of morphia is dissolved, and may be obtained in the form of crystal. The meconic acid and the morphia may be identified by their proper tests.

Though other processes have been recommended, this process, which has the advantage of separating both the meconic acid and the morphia, is in skilful hands a satisfactory one. Christison states

(p. 641), that by a process similar to the one just described, he has succeeded in obtaining distinct evidence of morphia and meconic acid by all the tests, in an infusion of ten grains of opium in four ounces of water. But on proceeding to apply the process to organic mixtures he found that when the soluble part of ten grains of opium was mixed with four ounces of porter or milk, he could detect no property of morphia, except its bitterness, and but faint indications of meconic acid by the permuriate of iron.

The fact now stated would lead us to expect few or no traces of opium in the stomach in the majority of cases of poisoning by it and its preparations. Very large quantities of the drug in its fluid preparations may be taken, and yet be detected neither by the odour, nor by the taste, nor by the several tests, even where death takes place most rapidly; and it may be stated as a general rule that, in poisoning with opium, the medical jurist, by the best methods of analysis yet known, will often fail in procuring satisfactory evidence, and sometimes fail to obtain any evidence at all, of the existence of the poison in the contents of the stomach. Even the odour may be absent in the liquid removed within half an hour after an ounce and a half of laudanum has been taken on an empty stomach, and when present is so mixed up with other odours, that it cannot be detected with any certainty. (Bright's 'Reports of Medical Cases,' ii. 203).

From what has now been stated it will be inferred that we have no reason to expect the discovery of opium in the secretions or solids of the body by any process of analysis, though there is no reason to doubt that the poison is absorbed, circulated in the blood, and deposited in the tissues. For information on this point, and for a description of other modes of dealing with organic liquids see 'Taylor on Poisons,' 2nd edit., p. 631.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—There is so much difference between the symptoms present in different cases of poisoning by opium, and at different stages of the action of the drug, that it is quite impossible to give the history of an average case of poisoning within the ordinary compass of a description.

The symptoms due to a poisonous dose of opium, or its preparations, are giddiness, drowsiness, and listlessness, followed by stupor, passing by degrees into a state of complete insensibility. The patient lies as if in profound sleep, breathing slowly and almost imperceptibly, with the eyes shut, the pupils contracted, the pulse either very frequent, or full and slow, the skin warm and moist, and the face flushed. At first the patient can be easily roused by loud noises, sudden movements, or slight blows; but, in a more advanced stage, he is kept awake with great difficulty, by violent shaking, loud speaking, tickling the nostrils, injecting water into the ear, or flecking the

hands and feet with a towel; and at length falls into a state of complete coma, with stertor, slow and noisy respiration, a slow and full pulse, a pale countenance, and livid hands and lips. Nausea and vomiting are sometimes present from the first, but in other cases they are among the early signs of recovery. When the patient is kept roused, by being briskly moved about, he is subject to constant retching, even though no emetic has been used. The bowels are generally confined. In fatal cases death takes place sometimes as in apoplexy, sometimes in a state of collapse, sometimes from apnœa, sometimes in convulsions, sometimes in a palsied state. In patients who recover, a long deep sleep with a remarkably slow breathing (I have counted it in a female as low as 6 in the minute, while the pulse was upwards of 80), is followed by a stage of painful nervous excitement, with headache, and distressing nausea. The recovery is ultimately complete.

Occasional Symptoms.—Spontaneous Vomiting, Diarrhœa, Diuresis: Delirium, convulsions (most common in children), sometimes alternating with stupor, locked-jaw and tetanic spasms, paralysis, anæsthesia, dilated pupils, or one pupil dilated the other contracted (Taylor), and the reflex function active, and easily excited, though the patient is otherwise quite insensible. The *pulse* sometimes nearly natural in frequency and force; in other cases full and accelerated, but this happens chiefly in the first stage. In the stage of insensibility, while the patient can still be roused, the pulse is generally full and slow, but towards the fatal termination it becomes small, frequent, and irregular. The respiration is much more uniformly affected than the pulse. Itching and dryness of the skin are also among the occasional symptoms.

Anomalous Cases.—An absence of the usual narcotic symptoms, with sudden death. A long postponement of the symptoms. Recovery for a time, with fatal relapse.

Post-mortem Appearances.—These are neither constant nor well marked. The most usual are turgescence of the vessels of the brain, with or without serous effusion under the arachnoid, into the ventricles, at the base, and around the spinal cord, very rarely accompanied by extravasation of blood. The stomach and intestines are generally healthy. Lividity of the skin, congestion of the lungs, a fluid state of the blood, and early putrefaction of the body are among the less constant appearances.

First Appearance of the Symptoms.—The poison, when taken in large quantity, and in a fluid state, may begin to act within a few minutes, and coma may be fully formed within half an hour. Even when taken in the solid form, complete stupor has been present in as little as fifteen minutes. Sometimes, however, the action of the poison, even though a large dose has been taken, is postponed for half an hour, an hour, or an hour and a half; and cases are even on record in which large quantities of the poison have not produced any serious effect till the lapse of 3, 5, 9, 10, and even 18 hours. One of the

most recent of this curious class of cases was published in the 'Lancet,' July 15, 1857, by Dr. Gibbs. Twelve drachms of laudanum were spontaneously rejected from the stomach at the end of 9 hours, without having given rise to any marked symptoms. The patient was a little exhausted, and the pupils were contracted.

The action of the poison is more prompt when taken on an empty than on a full stomach; when in a liquid state than when swallowed in the solid form; when the patient remains still than when he takes exercise immediately after swallowing the poison; and it is probable that the action is postponed and diminished by spirituous liquors.

The *shortest period* within which opium or its preparations have proved fatal to adult persons is three quarters of an hour. Cases of death in two hours are reported by Beck and Taylor; few cases are prolonged beyond *twenty-four* hours, and the *average* may be stated at from *seven* to *twelve* hours. When a patient survives *twelve* hours there is good hope of his recovery.

The *smallest* quantity of opium which has proved fatal in the adult is four and a half grains.* A quantity of the extract equivalent to four grains of solid opium has also destroyed life. Enormous quantities have been taken with impunity. In one instance recovery took place after no less than eight ounces of solid opium.

In very young children extremely small doses produce very marked effects, and have proved fatal. Cases are on record in which an eighth of a grain of opium, or its equivalent, has killed an infant two days old, a sixth of a grain an infant of four, and another of five days, a fifth of a grain an infant of three days old, a third of a grain an infant of nine months, and another a few weeks old, a fourth of a grain a child of fourteen months, less than half a grain a child of four years and a half. Two drops of laudanum killed an infant. Severe symptoms have been produced by a single grain of Dover's powder, containing a tenth of a grain of opium. A child of four months, and several infants, have suffered severely from quanities of laudanum equivalent to the sixth of a grain of opium.†

Death has happened, in the instances referred to, in intervals of time varying from 7 to 18 hours. As in the adult, so in infants and young children, recovery has taken place after considerable doses of opium. In a case under my own observation a child of six months recovered from ten grains of Dover's powder.

There are some persons on whom comparatively small doses of opium and its preparations, in consequence of peculiarity of constitution, produce unusually severe effects. On the other hand, the power of habit in lessening the effect of the poison must not be overlooked.

Opium, like tobacco, may be taken in constantly increasing doses

* This was mixed with nine grains of camphor. Case reported to Dr. Christison by Mr. W. Brown. 'On Poisons,' p. 657.

† For details of these cases, with the particular preparations given, see the works on Toxicology of Christison and Taylor.

with impunity. Thirty grains of solid opium, and even one hundred grains, are often taken in the day by opium eaters, and De Quincey, the English opium eater, brought himself to take nine ounces of laudanum, equivalent to 333 grains of solid opium in the day. There is scarcely a druggist in London who has not seen laudanum swallowed by the wine-glassfull; and I am informed that the Lascar beggars purchase half an ounce of opium a day, from which they procure a watery extract which they smoke with tobacco.

Opium, when thus taken habitually in large quantities, and for long periods, causes emaciation and loss of vigour, loss of appetite and constipation, loss of mental vigour, severe neuralgic pains, premature old age, and early death. Hobhouse describes the opium eaters of Constantinople as 'pale, emaciated, and rickety, sunk into a profound stupor, or agitated by the grimaces of delirium.'

Mr. Madden and Dr. Oppenheim confirm this account. The former adds, that a regular opium eater seldom lives beyond thirty years, if he commence the practice early; and the latter tells us that those who begin the practice early seldom attain the age of 40.

In the face of these explicit statements, and of the extreme improbability that a habit so unnatural should not affect the duration of life, it has been denied that the practice of opium-eating tends to shorten life. There is no doubt that many persons who indulge in it (but in a less degree than in the cases referred to by Hobhouse, Madden, and Oppenheim), live to a good age; but it is probably with opium as with spirits and tobacco, those who indulge in them and live long would attain a much greater age if their habits of life were other than they are. At any rate, the facts hitherto collected are not sufficient to decide this question.*

Opium applied to the skin, and especially to an abraded surface, or used in the form of injection, or introduced into the nostril or ear, may produce dangerous or fatal results. M. Tournon, of Bourdeaux, relates a case in which death was attributed to four grains of opium introduced into the external meatus of the ear.

Treatment.—The treatment must begin with the use of the stomach-pump, and warm water should be freely injected and withdrawn till it is discharged without odour and colour. If the stomach-pump cannot be immediately applied, an emetic of sulphate of zinc should be given; or, if this is not at hand, a table-spoonful of mustard, mixed with water. At the same time, vomiting should be encouraged by the free use of warm water, and by tickling the throat with a feather. If the patient is comatose, cold water should be freely dashed over the face, head, and neck, till he is somewhat roused from the stupor, and he must then be kept awake by causing him to walk rapidly between two assistants, shaking him and shouting to him. In small apartments, where it is inconvenient to move the patient about, the object of keeping the patient roused may be accomplished by flecking

* For cases, see Christison on the case of the Earl of Mar, p. 661.

the hands and feet with a towel. When the patient is beginning to recover, strong coffee should be freely administered. If emetics administered by the mouth do not act, they may be injected into the bowels, and, in hopeless cases, a solution of tartar-emetic might be introduced into a vein. Galvanism and artificial respiration have been used in extreme cases. When the symptoms present are those of collapse, ammonia may be freely given internally and applied to the nostrils; when those of apnœa, warmth and friction to the surface are indicated; when those of cerebral congestion, the moderate abstraction of blood by bleeding or leeches. In the stage of excitement which follows recovery, as well as in the early stage of the poisoning, cold affusion has been practised with excellent effect.

MORPHIA AND ITS SALTS.

Of this alkaloid, which is found in opium in proportions varying from 2 to more than 10 per cent., there are three salts in use in medicine—the acetate, hydrochlorate, and sulphate, of which the first two supply officinal preparations, namely, the liquor morphiæ acetatis and the liquor morphiæ hydrochloratis, which contain one grain of the salt in a drachm. The hydrochlorate of morphia is the preparation in most common use, and its ordinary dose for the adult is an eighth of a grain. The acetate of morphia is sold as a snow-white powder, or as imperfectly formed crystals, and the hydrochlorate either as a white powder, or in the form of silky acicular crystals. Both salts have the chemical reactions of morphia itself.

Symptoms.—Those of opium and its preparations. The symptoms set in somewhat earlier, and contraction of the pupils, with great dimness of vision or actual blindness, is a very constant symptom. Intense itching of the skin is also very common, and dysuria, tetanic spasms, and strong convulsions are among the occasional symptoms.

Anomalous Cases.—In one case reported by Dr. Shearman ('Med. Times and Gazette,' March 7, 1857), a grain and a half of the acetate of morphia in divided doses caused twitching of the limbs and face, with difficulty in swallowing, spasms of the muscles of the arms and legs, and of the muscles of the abdomen, partial opisthotonos, and great activity of the reflex function. Morphia was found in the urine. The patient recovered. A similar case of poisoning by twenty-two grains of the muriate of morphia, in which locked jaw, tension of the abdomen, and occasional convulsions, were present, is related by Orfila, and cited by Christison (p. 725). In one case, also, delirium seems to have followed its application to a blistered surface.

It is worthy of observation that Augustus Ballet, the presumed victim of Castaing, had, in addition to vomiting and purging, convulsions, locked jaw, rigid spasms of the neck and abdomen, inability to swallow, loss of sensibility in the legs, contracted pupils and stertorous breathing; and that Castaing, who prescribed for Ballet, and gave him

food and medicine, was proved to have recently purchased twelve grains of tartar emetic, and twenty-six grains of acetate of morphia.

John Parsons Cook, the victim of William Palmer, took two pills containing half a grain of acetate of morphia on each of the two nights preceding his first attack; and on the night of the attack itself two pills were given by Palmer, and again two pills on the occurrence of the tetanic symptoms. On the succeeding night, which was the night of his death, Cook also took two pills given him by Palmer, who had previously obtained the acetate of morphia pills from the medical attendant; and during the fatal attack two other pills, said to contain ammonia, were given. If all these pills contained acetate of morphia in the dose first prescribed, an aggregate of three grains would have been given within three days, of which quantity two grains were administered in little more than twenty-four hours. As the lady attended by Dr. Shearman was severely attacked with symptoms of tetanus from taking three doses of half a grain of acetate of morphia within seven hours, it is quite possible that the same drug in the same dose, and the aggregate of three grains in the space of seventy-two hours, may have proved fatal to a patient previously reduced by tartar emetic. It is not intended by these observations to raise any doubt of the guilt of Palmer, but merely to suggest the possibility of the death of Cook having been occasioned by acetate of morphia and not by strychnia.

Fatal Dose.—In the case of this, as of most other active poisons, very large doses have been taken with impunity, and very small ones, in certain states of the system, have been followed by dangerous symptoms. One case has been reported in which half a grain of the acetate of morphia given as a medicine to a female in ill health was supposed to have proved fatal ('Lancet,' Nov. 1838), and it is probable that less than a grain of morphia given in one dose would prove fatal to an adult.

Treatment.—That proper to poisoning by opium and its preparations. Finely-divided animal charcoal suspended in water might be administered with advantage after the use of the stomach-pump.

CHAPTER XIV.

HYDROCYANIC ACID.

HYDROCYANIC, or prussic acid, with essential oil of bitter almonds, of which it is the active principle, and cyanide of potassium, one of its salts, form a group of poisons ranking next to opium and its preparations in the frequency with which they are taken as poisons.

In the two years 1837–8, twenty-seven cases of poisoning by prussic acid were brought under the notice of the coroner's court, of which eight (all cases of suicide) occurred in medical men and druggists. Four cases of poisoning by essential oil of almonds also occurred in those years, and one of poisoning by prussic acid mixed with arsenic. Prussic acid, with its preparations and compounds, caused, on the average of those years, sixteen deaths. But on the average of the five years 1852–56, they were credited with 34 out of the 268 deaths from ascertained poisons. The use of this poison is, therefore, on the increase.

In the five years, 93 deaths were attributed to prussic acid, of which 83 in males and 10 in females; 75 to the essential oil of almonds, of which 45 in males and 30 in females; and 2 to cyanide of potassium, of which one in a male the other in a female. The great majority were adults. One murder only was committed by any of these substances; and that one was by the essential oil of almonds. The remainder of the deaths were suicidal or accidental; and 75 by prussic acid, 51 by essential oil of almonds, and 1 by cyanide of potassium were ascertained suicidal acts.

This poison is remarkable for its quick and fatal effect, and this, coupled with the frequent use of the essential oil of almonds in cookery, and of the cyanide of potassium in the arts, renders it a favourite instrument of suicide. It has been only occasionally used as an instrument of murder. For medicinal purposes, the acid is formed by a complex chemical process, or by the decomposition of salts which contain it; but it also exists in the leaves, flowers, and fruit-kernels of many plants belonging to the natural order Rosaceæ. The bitter almond, the cherry-laurel, the peach, the cluster cherry, and the mountain ash; the kernels of peaches, plums, and cherries, and the pips of apples, contain it. The prussic acid obtained from these sources is mixed with an essential oil, and distils along with it. The cherry-laurel water was administered as a poison in the well-known case of Sir Theodosius Boughton; and a bitter almond water improperly kept in the shops of very variable strength, and incautiously prescribed, has also proved fatal.

The acid is met with under two forms; as a pure anhydrous acid, and diluted with water.

The pure anhydrous acid is limpid and colourless, has an acrid pungent taste, and a peculiar odour. It boils at 80°, freezes at 5°, and at ordinary temperatures readily freezes by its own evaporation. If left exposed to the light, it soon decomposes and turns brown. It is highly inflammable. The pure acid is not likely to come under notice in medico-legal cases: it is the dilute acid, as kept in the shops, that is commonly used as a poison.

Dilute Hydrocyanic Acid.

Properties.—The dilute acid has the same appearance, odour, and taste as the strong acid, but provided it be kept from the light, is not so apt to decompose. Like the strong acid it is volatile, though in a less degree, and loses its activity by exposure. But the acid obtained by decomposing a solution of ferrocyanide of potassium by sulphuric acid is much more stable, and has been kept for years, even exposed to diffused light, without undergoing decomposition. The quantity of the strong acid contained in the dilute acid employed in medicine differs with the mode of preparation, and the time that it has been kept. As found in the shops, the strength has been found to vary from 1·3 to 6·5 per cent. (Taylor.) This variation of strength in the same medicinal preparation is well illustrated by the case of a French physician referred to by Christison, who swallowed a whole ounce of one sample of Scheele's acid, and a drachm of a stronger sample without injury; but on trying some recently prepared by Vauquelin, he had a narrow escape of his life.

The prussic acid of the London Pharmacopœia should contain about 2 per cent., that of Vauquelin, 3·3 per cent., and that of Scheele about 5 per cent. The strength of the dilute acid employed in other countries varies from 1 to 25, or even 50, per cent.

Among the properties of prussic acid just described, there is one which is so characteristic and so delicate as to be justly regarded in the light of a test, namely—

The odour.—This is peculiar, and generally perceptible even where the acid is present in very small quantity. As a test, it has the advantage of not being dependent on any chemical knowledge or skill on the part of the observer, and when perceived by more than one person, and especially when recognized by several persons at the same time, it is conclusive of the presence of the acid. It has, indeed, been alleged that the odour of prussic acid is not decisive; because nitrobenzole, one of the products of coal-tar, and some other artificial products used as scents or flavours, have a like odour, and because the brain itself has an odour similar in kind though faint in degree. Of nitro-benzole it will suffice to observe that it is itself an active poison; of the objection founded on the faint similar odour of the brain, that it

has a very limited application in post-mortem inspections, and of both that they are very unlikely ever to constitute real objections.

The odour of the acid, considered as a highly characteristic property and test, finds its application both during life and after death—during life, as indicating at once what poison has been taken, by the odour diffused through the air, or perceptible in the breath; in the dead body, as equally indicating the presence of the poison in the contents of the stomach or in the tissues.

In patients under treatment, the odour of the acid may be disguised by that of other remedies, as in a case which fell under my observation, in which assafœtida had been administered in an injection.

The odour, as perceived in the dead body, is generally recognizable soon after death, but it often disappears in less than twenty-four hours. In the case of Sarah Hart, the victim of Tawell, the odour was recognized by two only out of five witnesses, eighteen hours after death. In a case reported by Mr. Newham, of Bury St. Edmunds, it was perceived eleven hours after death in the stomach, heart, and brain; and in an interesting case of double suicide (that of C. W. Duckett and Elizabeth Williams, reported by Dr. Letheby), it was perceived about the mouth twelve hours, and according to Mr. G. Davies, seventeen or eighteen hours after death.

The odour of prussic acid is therefore to be regarded as a highly characteristic property, and even a valuable test of the presence of the poison.

Tests.—There are four recognized tests for prussic acid, which may be briefly designated as the copper, silver, iron, and sulphur tests. These tests are equally applicable to the acid in solution and in vapour.

1. *Copper Test.*—A solution of sulphate of copper added to a liquid containing hydrocyanic acid gives characteristic results. The liquid is first rendered slightly alkaline by liquor potassæ; and on adding the solution of sulphate of copper, a greenish-white precipitate is thrown down, which, on the addition of a little hydrochloric acid, becomes nearly white, the blue oxide of copper which is mixed with the white cyanide being re-dissolved.

Though this test was recommended by Lassaigne as a very delicate one, it is less characteristic than the three remaining tests.

2. *Silver Test.*—A solution of nitrate of silver gives with liquids containing hydrocyanic acid a white clotted precipitate, distinguished from the other white precipitates thrown down by nitrate of silver, by its insolubility in nitric acid at common temperatures, and its solubility at a boiling heat. If the precipitated cyanide of silver, after being well washed and dried, is introduced into a small tube closed at one end, and drawn out at the other into a fine point, and the precipitate is heated by the flame of a spirit-lamp, cyanogen gas is given off, which, on being lighted, burns with a highly characteristic crimson flame, surrounded by a blue halo.

3. *Iron Test.*—Add to the suspected liquid a slight excess of liquor

potassæ, then a few drops of a mixture of the proto-sulphate and persulphate of iron in solution. A brownish-green precipitate is thrown down, which, on the addition of a little dilute hydrochloric acid, becomes Prussian blue.

4. *Sulphur Test.* (Liebig's Test.)—To the liquid containing the acid add a few drops of the sulphide of ammonium; then heat the liquid gently till it becomes a pure white or colourless; then evaporate slowly. A white amorphous sulpho-cyanide of ammonia remains, which assumes an intense cherry-red colour when touched with a solution of the perchloride of iron. This colour is ~~not~~ discharged by a solution of corrosive sublimate.

When these tests are applied to detect the acid by its *vapour*, the following method of procedure is to be observed:—

Place the fluid or substance yielding the vapour in a watch-glass; moisten a large flat disc of glass with the test; invert it over the watch-glass, with the moistened surface downwards, and allow it to remain for ten minutes or more, or till a distinct reaction is perceptible through the glass. Or, place the liquid or substance in a small wine-glass with a conical stem, moisten with the test two flat glass discs—a smaller and larger one—and insert them over the contents of the glass, so that the vapour which passes the first disc may act upon the second.

In the case of the *copper-test* use a solution of sulphate of copper, of the strength of 1 gr. to the ounce. Moisten the disc of glass with a drop of this solution rendered slightly alkaline by dilute liquor potassæ; and after exposure add a drop of dilute hydrochloric acid. Compare the dried stain with the stain from a drop of the test-solution of sulphate of copper.

In the case of the *silver-test*, moisten the glass disc with a solution of nitrate of silver (gr. 1 to f℥i). The colourless solution soon becomes opalescent, and when dry, leaves a white stain. Examine the stain under the microscope. Some parts of it will be found to consist of distinct needles more or less thickly interlaced. Compare the stain with that left by a drop of the test solution. It is faintly white, and shows under the microscope no distinct crystalline form.

In the case of the *iron-test*, moisten the glass disc with a drop of liquor potassæ, and after due exposure, add a drop of the fresh solution of the mixed sulphates of iron. Develop the Prussian blue by a drop of dilute hydrochloric acid. Compare with the Prussian blue the brown oxide of iron thrown down by the addition of liquor potassæ to the test liquid.

In the case of the *sulphur-test*, moisten the glass disc with the sulphide of ammonium, allow the white stain of cyanide of ammonia to dry, and test with a drop of the perchloride of iron solution. Compare the cherry-red of the sulpho-cyanide with the yellow of the dry spot of perchloride of iron. To increase the contrast use a solution of the perchloride diluted with distilled water so as to be nearly colourless. As the liquid in the watch-glass will have absorbed a portion of the vapour

of the sulphide of ammonium, and changed to white, it should be evaporated to dryness, and tested with the perchloride of iron. This test, as two vapours are in presence of each other, is always applicable both to the stain and to the liquid under examination.

Of these four tests of prussic acid in vapour, I have found the nitrate of silver the most satisfactory. A single apple-pip bruised and moistened with distilled water, and placed in a watch-glass, yielded as many as twenty-two distinct reactions. The solution of nitrate of silver was rendered opalescent in every instance, and the dried stain was found to contain microscopic crystals of the cyanide of silver. The results obtained with the other tests in a comparative experiment, under exactly similar circumstances, were less satisfactory. Three apple-pips were bruised, moistened, and placed in three watch-glasses; and the three tests were used in the manner already described for ten successive exposures of five minutes each. The nitrate of silver tests acted characteristically in the ten experiments; the Prussian blue test succeeded in three; and Liebig's test in one. But the liquid in the watch-glass used for this test was found to have been whitened by the sulphide of ammonium, and on being evaporated yielded a white stain, which gave a distinct and characteristic reaction with the per-salt of iron.

Hydrocyanic Acid in Organic Mixtures.

The acid being highly volatile, the examination of organic liquids supposed to contain it, should on no account be delayed; and though the acid has been detected in the body after several days, the same precaution should be observed in reference to the post-mortem examination, and the analyses which may arise out of it.

For the detection of hydrocyanic acid in compound mixtures, nitrate of silver cannot be immediately employed, as it throws down a white precipitate with hydrochloric acid, of which there is always some in the contents of the stomach, as well as with salts containing that acid, such as common salt. We must therefore resort to a process of distillation. But previous to doing so, we may advantageously apply the four tests already described to the vapour given off by the organic substance. The process of distillation is to be conducted as follows:—

The filtered liquid, if alkaline, is to be neutralized by sulphuric acid, which will fix any ammonia disengaged in the process of putrefaction. The mixture is then to be distilled from a water bath, at a temperature of about 150°, till about an eighth part has passed over into the receiver. This distilled fluid is then to be tested by the reagents just described.

It has been objected to this, and every other process in which heat is employed, that hydrocyanic acid may be formed during the distillation by the decomposition of animal matter. This is a mere conjecture, altogether unsupported by experiment. It has also been

objected that hydrocyanic acid may be formed by the processes of putrefaction and decay in various animal and vegetable matters, such as cheese and the ergot of rye.

These objections are futile in all those cases in which persons are found dying or dead with the odour of prussic acid strong upon them; and in many cases they are effectually removed by analyzing the fluid contents of other parts of the body, such as the serum contained in the brain. In a case which the author saw during his pupilage, hydrocyanic acid could be readily detected by the odour in all parts of the body, and was found in the brain by a delicate process of analysis performed by Mr. Everett.

Quantitative Analysis.—Use for this purpose the precipitated cyanide of silver, every 100 grains of which correspond to 20·33 grains of the pure anhydrous acid, of which the prussic acid of the London Pharmacopœia contains two per cent.

EXPERIMENTS ON ANIMALS.

Hydrocyanic acid is, in all its forms, a most active and energetic poison. Animals made to breathe air saturated with the vapour of the anhydrous acid, die instantaneously (Pereira), or in from one to ten seconds (M. Robert). In the fluid form the anhydrous acid is scarcely less rapid in its action. A single drop put into the throat of a dog killed the animal after two or three deep hurried respirations; it caused death almost as quickly when dropped under the eyelid; and when injected into the jugular vein, the animal fell dead at the very instant, as if struck with a cannon ball, or with lightning. (Majendie.)

A single drop in the mouth of a rabbit began to act in sixty-three seconds, and killed it in eighty-three seconds; three drops began to act on one cat in ten seconds, and on another in five seconds, killing the first in thirty seconds, and the second in forty seconds; four drops began to act on a rabbit in twenty seconds, and killed it in thirty seconds; and twenty-five grains, corresponding with an ounce and a half of medicinal acid, began to act on a rabbit as soon as it was poured into its mouth, and killed it outright in ten seconds at furthest. Three drops projected into the eye, acted on a cat in twenty seconds, and killed it in twenty more, and the same quantity dropped on a fresh wound in the loins, acted in forty-five seconds, and proved fatal in a hundred and five seconds. In the slower cases, there were fits of violent tetanus; but in the very rapid cases the animals perished just as the fit began to show itself with retraction of the head. In rabbits the spine was bent back, in cats it was curved forwards. (Christison.)

The concentrated acid, then, according to its quantity, and mode of administration, may begin to act on the animals usually submitted to experiment instantaneously, or in from five to sixty-three seconds, and may prove fatal in from ten to one hundred and five seconds; when

dropped into the mouth it may begin to act in from five to ten seconds, and prove fatal in from thirty to forty seconds.

The effects of the dilute acid on animals have been reported by several observers; among others by Mr. Nunneley of Leeds, to whom we are indebted for a very large and carefully conducted series of experiments, mostly on dogs. It results from these experiments that a large dose of the dilute acid causes death as promptly as the concentrated acid; and that moderate dilution not only does not impair, but even somewhat enhances its effects. (Nunneley.) Large doses of the dilute acid destroy life in from two to fifteen minutes; but life may be prolonged, after a fatal dose, for hours or even days. A dog poisoned by the dilute acid died after nineteen days of suffering. (Coullon.)

When the dose is short of a fatal one, the animal is seized in one or two minutes with giddiness, weakness, salivation, and protrusion of the tongue, hurried and panting respiration, lividity of the face, and protrusion of the eyes; with convulsions or tetanic spasms, passing into paralysis, and insensibility; after lying in this state some time, the sensibility and power of motion are gradually restored, with slight convulsions and gasping respiration, and sometimes with powerful convulsions and loud howlings. The animal then falls asleep, and wakes up recovered but feeble. This sleep is sometimes so profound as to resemble the effects of opium. The breath of the animal is said to smell of the poison.

Several questions of obvious medico-legal importance relating to the symptoms of poisoning by prussic acid have been illustrated by experiments on animals. These will now be briefly indicated.

Convulsions.—Some importance naturally attaches to the question whether convulsions are to be classed among the common symptoms of poisoning by prussic acid. This question has been answered in the affirmative. Convulsions are generally present. But there is no doubt that exceptions to the rule are not infrequent. They are recorded by almost all who have experimented largely on animals, and large numbers of instances might easily be cited.

The shriek or cry.—This too is a common, but not constant, symptom. It is described by Mr. Nunneley as "a peculiar cry, indicative of severe distress, different from anything heard in any other state," and as he believes "characteristic of the poison." This cry of distress has been frequently reported as absent, and in Mr. Nunneley's numerous experiments on dogs was present in one half the cases.

Expulsion of Fæces and Urine.—In Mr. Nunneley's experiments, the fæces alone were passed in about a tenth of the cases; in another tenth both fæces and urine; in a far larger number of instances the urine alone; and in about two fifths of the whole number neither fæces nor urine.

Acts of Volition.—The dogs experimented on by Mr. Nunneley sometimes performed acts of volition before the poisonous effects showed

themselves. One dog, after taking the poison, "went down three or four steps of some stairs, saw the door at the bottom was closed, and came back again;" and another "went down, came up, and then went down again the whole flight of a steep winding staircase;" and a third "retained sufficient vigour to jump over one of the dogs, and then actually leaped completely across the open top of the staircase."

The *Post-mortem Appearances* in the animals submitted to experiment were not well marked. The brain is generally natural in appearance, though its vessels have been found turgid, and in one instance, in the horse, there was extravasation of blood between its external membranes. The heart and great vessels differ in their condition and in their contents according as the death occurs quickly or slowly. In cases of sudden death, the left side of the heart is, in almost every case, perfectly empty and rigidly contracted, while the right side contains blood sometimes in large quantity. In chronic cases, both sides of the heart are distended with black blood. (Nunneley.) Sometimes the blood is found florid, and though usually fluid, it is sometimes found coagulated. According to Magendie the pure acid so completely destroys the irritability of the heart and voluntary muscles, that they are insensible even to the stimulus of galvanism. It appears, however, that this result was not met with by other observers, and in Christison's experiments was not constant, occurring in some instances, but not in others. "In eight experiments on cats and rabbits with the pure acid the heart contracted spontaneously, as well as under stimuli, for some time after death, except in the instance of the rabbit killed with twenty-five grains, and one of the cats killed by three drops applied to the tongue. In the last two the pulsation of the heart ceased with the short fit of tetanus which preceded death; and in the rabbit, whose chest was laid open instantly after death, the heart was gorged, and its irritability utterly extinct." The lungs are sometimes empty, but more generally gorged with blood. The membrane to which the acid is applied is usually found congested. The corpse is generally very rigid.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—The symptoms of poisoning by prussic acid in the human subject vary, as experiments on animals would lead us to expect, with the dose, and with the age, strength, and state of the patient. When a large dose is taken, the symptoms begin in a few seconds or minutes after the swallowing of the poison. There is probably, in all cases, a short interval of consciousness, and then a sudden access of giddiness, rapidly followed by insensibility, deep catching respiration, and death in a short space of time. When the case is prolonged beyond a few seconds, or minutes, other symptoms are superadded.

If the fatal cases and those of greater severity are thrown into one group, the symptoms may be thus briefly described:—There is insen-

sibility, deep catching respiration, loud mucous rattle, cold and blue skin, dilated pupil, very rapid pulse and breathing, rigid contraction of the jaw, tetanic spasms or strong convulsions of the extremities, and, in some cases, discharges of urine and fæces. In protracted fatal cases, and in rare cases of recovery, the leading symptoms are dyspnœa, loud mucous rattle, slight convulsions, and salivation. In acute cases, the cause of death is shock, in chronic cases, suffocation. In rare instances narcotic symptoms are present as in poisoning by opium.

The short interval of consciousness which, as has just been stated, probably occurs in all cases of poisoning by prussic acid, is sometimes filled in by voluntary acts. A few persons, after swallowing large doses, have merely staggered a few steps, and sunk down without a groan, apparently lifeless, and died after a few convulsive expirations, in less than four minutes after swallowing the poison; others have uttered expressions of fear, and then fallen as if struck by lightning. In many cases the patients were heard to fall without having uttered any sound previously.

In smaller doses, the action of the poison occasions nausea, salivation, followed sometimes by ulceration of the mouth, a rapid pulse, and weight and pain in the head, succeeded by a feeling of anxiety which does not pass off for several hours.

Post-mortem Appearances.—The countenance is pale and composed, the eyes glistening, the venous system gorged with blood of a glimmering blue tint, the vessels of the brain charged with blood, with some effusion of serum into the ventricles. Traces of inflammation, or congestion, of the mucous membrane of the stomach, congestion of the lungs, and a deep blue colour of the bile, have been mentioned among the occasional post-mortem appearances. Putrefaction makes rapid progress as in most other forms of sudden death.

The stomach and every part of the body exhale the odour of prussic acid. But this is not a constant phenomenon. It may be expected to be absent in cases of poisoning, where the patient survives long enough to exhale it freely from the lungs, or where the body has been for some time exposed to the air under circumstances favourable to evaporation. It has been recognized in the stomach, and not in other parts of the body, and, on the other hand, it has been perceived in other parts of the body when there was no trace of it in the stomach. The odour is most conclusive when perceived in the blood or limbs; for it has been asserted occasionally to exist in the stomach and intestines, and in the brain, where no substance containing prussic acid has been taken.

Treatment:—Antidotes. Chlorine and the mixed oxides of iron are antidotes to prussic acid. The one acts by withdrawing the hydrogen of the poison, the other by forming with it the insoluble Prussian blue. But there are few cases in the human subject in which an antidote can be applied, and none in which the preparation of an antidote would not prove a loss of valuable time. In the great majority of cases the

medical man is called to a suicide already dead, or *in articulo mortis;* and when the patient is still alive, the jaw is so firmly closed as to render the introduction of an antidote very difficult, if not impossible. The treatment must therefore be independent of the use of antidotes.

The first step to be taken is to administer the *cold affusion* as a shock. Water must be dashed into the face, or freely poured on the head and back. As soon as the patient is roused, though still insensible, and perhaps in convulsions, the face and trunk must be wiped dry, the clothes must be removed, and the patient be placed in bed. A sponge or rag sprinkled with ammonia, or with disinfecting fluid, may now be held to the nostrils, and the surface of the body must be kept warm by hot cloths or flannels, and by frictions with the hand or flesh-brush. As soon as the jaws can be opened, and the patient be made to swallow, an emetic of sulphate of zinc, of mustard, or of common salt should be given; or the stomach-pump may be employed.

what?

Smallest fatal dose.—This may be stated for the adult at somewhat less than a grain of the pure acid or about 45 minims of the acid of the Pharmacopœia. Very severe symptoms have been occasioned by about half a drachm of this acid, but recovery has taken place from doses of seventy or eighty drops.

Commencement of the Symptoms.—The period at which the symptoms first show themselves is a point of considerable importance, and closely connected with the question—What amount of voluntary motion is possible after swallowing a large dose of the poison?

There are no cases on record of that instantaneous action in the human subject which has been noted in experiments on animals. But when a large dose of the acid is taken the symptoms set in very soon, and death is very sudden. In a case reported by Hufeland a quantity of the poison equivalent to forty grains of the pure acid was taken. The man was seen to swallow the poison, was observed to stagger a few steps, and then to sink down without a groan apparently lifeless. It may be fairly assumed, then, that when the dose is very large, the symptoms manifest themselves almost instantaneously. But in the case of smaller fatal doses, or of doses productive of severe effects, a short interval elapses between the taking of the poison and the loss of sense and power.

The voluntary acts which can be performed in this interval will be presently ascertained by an appeal to recorded cases.

Fatal Period.—After a large dose of the poison, death appears to take place in from two to five minutes. But the poison may not prove fatal till the lapse of twenty minutes, half an hour, three quarters of an hour, or an hour. A patient of mine, to whose case allusion will presently be made, was in a very dangerous state for six hours; and then began to recover.

Voluntary Acts.—The question whether, after taking a large dose of prussic acid, the patient retains his consciousness for a time, and whether, during that interval, he is in a condition to perform certain

voluntary acts? may become important in a medico-legal point of view. In favour of the retention of consciousness I have the distinct statement of the patient whose case will be presently cited. That many voluntary acts may be performed in this conscious interval is proved by several recorded cases. The medico-legal import of the question will be understood from the following case.

An apothecary's maid-servant at Leicester, who was pregnant by Freeman, her master's apprentice, was found dead in bed, poisoned with prussic acid. The apprentice was suspected of having been accessory to her death; but, as it was proved that the deceased had made preparations for effecting a miscarriage, it was probable that she had taken the poison of her own accord. The question, whether the poisoning was suicidal or homicidal, could be answered only by a reference to the condition in which the body was found. It appeared, from the evidence, that the body lay at full length on the bed, with the head turned a little on one side, the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin; under the clothes, on her right side, lay a corked phial, wrapped in paper, and containing three drachms and a half of the poison. The leather and string which had fastened the cork were found in the chamber-vessel.* It was probable, therefore, that four and a half drachms of the poison had been swallowed; and the question arose, Could the girl, after swallowing this quantity of the poison, have corked the bottle, wrapped it up, and adjusted the bed-clothes?

This question can be answered only by an appeal to fatal suicidal cases in which acts of volition have been performed; or by comparing the time which such acts require for their performance, with ascertained intervals of consciousness in the human subject. The experiments on animals performed by some of the medical witnesses examined in this case, though useful as illustrations, are quite inconclusive.

The following facts are recorded in illustration of the question raised in this case:—An apothecary's assistant in Germany took four ounces of the hydrocyanic acid of the Bavarian Pharmacopœia, and was found dead in bed, with an empty two-ounce phial on each side of the bed, and the bed-covering pulled up as high as the breast, the right arm extended beneath it, and the left arm bent at the elbow. In a suicidal case reported by Mr. Newham of Bury St. Edmunds, the bed-clothes were smoothly drawn up to the shoulders; and on a chair close to the back of the bed there was a phial with the cork in it. A third case of the same kind was communicated to Dr. A. Taylor by one of his pupils. A man found dead on the seat of a water-closet, had the bottle from which the poison was taken corked in his pocket. In a curious case of double suicide reported by Dr. Letheby, the bodies were found in positions which implied a succession of slight voluntary movements.

These facts are sufficient to prove the possibility of some slight

* See this case very fully reported, 'Medical Gazette,' vol. viii. p. 759.

voluntary efforts being made after swallowing a large dose of prussic acid; and they must be held to justify, as far as this particular question is concerned, the verdict of acquittal pronounced in favour of Freeman.

But the voluntary acts which may be performed after fatal or highly dangerous doses of this poison go much beyond those inferred from the position of the bodies in these instances. The voluntary acts may be more numerous and more considerable. In the suicidal case presently to be more minutely described a large dose of the poison was taken in bed; but the lad was able to get out of bed, to walk round the foot of the bed to a chest of drawers at a distance of two or three yards, to place the stopper firmly in the phial, and to return to the side of the bed whence he fell senseless.

In another class of cases the suicide, in addition to other movements implying volition, has been able to cry for help and even to converse.

An apothecary's apprentice who had been sent from the shop to the cellar had only been a few minutes away when his companions heard him cry, in a voice of great alarm, "Hartshorn! hartshorn!" On instantly rushing down stairs, they found him lying on the lower step, grasping the rail; and he had scarcely time to mutter, "Prussic acid!" when he expired not more than five minutes after leaving the shop. He had taken a drachm of the Bavarian acid, had tried to get at the ammonia, but had not strength to uncover the bottle.

In two cases reported by Mr. Nunneley of Leeds, the patients not only moved about, but spoke and answered questions, after taking, the one a fatal, the other a large dose of the poison. The subject of the first case answered a question addressed to him some minutes after he had swallowed the poison, and the man who recovered retained the use of his speech till the jaws gradually closed. One of the most remarkable cases illustrating the power of locomotion and of speech after a fatal dose of the poison is recorded by Dr. S. C. Sewell of Montreal.

A hypochondriac gentleman took seven drachms of prussic acid of the estimated strength of 3 per cent. Previous to swallowing the poison he locked himself in his room, but after about a minute unlocked the door, and cried out, "Come to me quick, I am dying." A servant immediately entered the room, and found him lying on his back on the sofa, with his legs crossed, insensible, and snoring. Dr. Sewell arrived in twenty minutes. He was then dead, and presented the appearance of profound slumber; the legs crossed, his arms by his sides, and his eyelids firmly closed.*

The effects of prussic acid when taken in a large, but not fatal, dose will be seen by the two cases which follow. The first case will be found described in the 'Revue Médicale' for February 1845, the second came under my own observation in the previous year.

* For more full details of some of the cases just cited, and for other cases of poisoning by hydrocyanic acid, refer to Ranking's half-yearly abstract of the Medical Science, vol. ii., p. 399.

Dr. B——, a physician at Rennes, having taken a teaspoonful of prussic acid, prepared by himself, in the morning, without inconvenience, took another teaspoonful, prepared after Scheele's method, after dinner. These two doses produced no marked effect. He then took a third teaspoonful of a preparation purchased of M. Vauquelin, and after an interval of a few seconds, another teaspoonful. This new preparation tasted a little stronger than the former doses, but Dr. B—— remarked that "it had not hurt him." But on walking out of the shop in which he had made this last experiment, he felt an alarming kind of disturbance in his head, and on returning he uttered a few expressions of fear, and fell down as if he had been struck by lightning. The teeth were, at this time, firmly closed, there was continually-increasing dyspnœa, with noisy and rattling respiration, coldness of the extremities, distortion of the mouth, redness and swelling of the face and neck, fixed and dilated pupil, and a pulse imperceptible in the left, and very small in the right arm. The trismus continued to increase in intensity, a short and violent convulsion followed, and the abdomen, especially about the epigastrium, became rapidly distended. Attempts were now made to rouse the patient by stimulant frictions with ammonia and cantharides, and by stimulant applications. Vomiting was also excited by tickling the throat with a feather, and some dark-coloured mucus was thrown off. After remaining in this state for two hours and a half, he began to show signs of returning reason, and recognized those around him. The intellectual faculties were gradually restored, but considerable difficulty of breathing and very distinct rattle remained, with occasional expectoration of yellowish black mucus. During the whole of this time the breath smelt strongly of prussic acid. Dr. B—— was thirteen days before he could go out to see his patients, during which time the dyspnœa was frequently distressing, particularly when he turned in bed, and when he awoke in the morning. At last he quite recovered. During the first four days very little urine was passed.

In the month of November 1844, I was called up at night to see a young gentleman who had swallowed prussic acid. The particulars of the case, as detailed by himself and his relatives, are as follows :—

He is the son of a medical man, is about nineteen years of age, and studying the law. His disposition is naturally cheerful; he has met with no disappointment, and never, until the present attempt, had contemplated suicide. His habits are temperate and industrious. On the afternoon of the day on which he swallowed the poison he dined in the Hall of one of the Inns of Court, and drank, according to his own account, half a bottle of wine—a quantity much exceeding that which he was in the habit of taking. On reaching home he was observed to be somewhat affected by liquor, and before going to bed went, under some pretence, into the surgery, from which he took a stoppered bottle containing, according to the estimate of his father and the apprentice, from one to two drachms of prussic acid of the Phar-

macopœial strength, but according to his own statement, about a mouthful. Soon after he had gone to bed the family was startled by a noise in his room as of a heavy body falling, and a relative, who was passing at the time, was alarmed by a loud gurgling noise. His father was almost immediately on the spot, and seeing the bottle on the drawers, dashed several buckets of water over the face and chest of his son. This roused him. He was then taken into an adjoining room, and put to bed, the treatment consisting in holding ammonia to the nostrils, and applying heat to the spine and feet. An injection was also given, containing tincture of assafœtida.

When I reached the house I found him in the following state, in which he had continued without alteration for three hours:—He lay on his back, drawing in his breath with great effort, each inspiration being accompanied by a loud gasping sound, and a distinct mucous râle. The pulse was upwards of 140 in a minute, and the respiration 36. The surface of the body was very cold; the countenance was of a dull leaden hue; the lips blue; the pupil extremely dilated, and the jaws rigid, in which state they had remained for the whole period, so that it had been impossible to administer any antidote.

The treatment from this time forward consisted in holding ammonia under the nostrils, assiduous frictions with the flesh-brush, and the application of heat to the surface by means of flannels warmed at the fire, and constantly renewed. At the expiration of about five hours there was some effort to vomit, encouraged by tickling the throat, and some bloody mucus was wiped from the mouth. Soon afterwards he could be made to swallow, when some warm brandy and water and some strong coffee were given him. At this time, too, he could be made to answer in monosyllables, and could raise himself on his elbows. He was also perfectly sensible, but looked bewildered. At the end of about six hours he was sufficiently recovered to answer questions, move himself about, and call for lemonade, which he drank freely. The mucous râle had disappeared, the respiration and pulse were still frequent, the pupil was restored to nearly its usual size, and the skin was warm. Being disposed to be quiet, and seeming out of danger, he was left to himself. After a time he complained of fulness at the pit of the stomach, and asked for an emetic, which was given him, with the effect of bringing off his stomach a large quantity of undigested food.

I saw him about fourteen hours after taking the poison, and found him quite well, though weak. He gave the following distinct account of the attempt of the night before:—He was suddenly tempted, as he said, by the devil, to take prussic acid, under a confused idea that it would not hurt him. He swallowed, according to his own account, a mouthful of the acid from the bottle in bed. He then got out of bed, walked round the foot of it to a chest of drawers standing within a few yards of his bed-side, placed the stopper so firmly in the bottle that it could not be removed, and then walked back to bed, intending to get

in again. He reached the side of his bed, sat down upon it, and then lost all consciousness. During all this time he said that he had no giddiness, and no unpleasant sensation of any kind, no more than if he had taken so much water. He also assured me, and his manner made me quite confident that he spoke the truth, that the idea of suicide had never before entered his head. The father of the lad has since informed me that the fæces, and, as he believes, the urine too, were expelled as the first effect of the poison.

On examining the bottle which had contained the prussic acid, it was found quite empty, so that it was not possible to ascertain the strength of the preparation which the lad had taken. From the statement of the father and apprentice that the bottle contained one or two drachms, and that of the lad himself, who affirmed that he had swallowed a mouthful, it is highly probable that the dose taken was such as to prove fatal had it not been for the prompt application of the cold affusion, the continued use of ammonia, and the assiduous application of warmth to the surface. At the time that I first saw the patient the remedies most strongly indicated, in addition to those already employed, were warmth and friction to the surface, of which the first had been already applied, but to an insufficient extent. The extreme coldness of the surface rendered such treatment imperative, and the blueness of the skin of the hands and face, the labouring respiration, and the abundant collection of mucus in the air-passages, furnished an additional reason for its assiduous application. Friction and warmth to the surface are as strongly indicated, after the patient has been in some degree roused from the first effect of the poison, as the cold affusion at the onset.

This case is especially interesting as showing the interval of perfect consciousness and complete command of the voluntary muscles which may intervene between the swallowing of a large dose of prussic acid and the development of the characteristic effects of the poison; and it is a very striking example of a large class of cases of suicide in which the impulse to the commission of the act precedes the act itself by a very short interval, and springs up during a temporary excitement of the mind. I have every reason to believe that the account which the lad gave me of the act itself, and of the sudden impulse which led to it was perfectly correct. His narration had all the appearance of openness and truth.

Three medico-legal questions which have been raised in cases of poisoning by prussic acid have still to be considered. To two of these questions some importance was attached in the case of Sarah Hart, the victim of Tawell. 1. Is there, in cases of poisoning by prussic acid, any death-cry or scream which would serve to announce the operation of the poison? 2. Are convulsions of common or of universal occurrence? 3. Is prussic acid a cumulative poison? 1. In answer to the first question it may be stated that a patient who is conscious of having swallowed the poison may call out for assistance; but the plaintive cry,

or louder scream, sometimes heard in animals has not yet been recorded in any case of poisoning in man. 2. It is probable that convulsions are not of more frequent occurrence in poisoning by prussic acid than in other cases of sudden death. The expulsion of the urine and fæces, which has been observed in certain cases, was probably accompanied in those cases by short convulsions, and in some instances (as in a case reported by Mr. Hicks) there have been muscular efforts expressive of intense anxiety and urgent want of breath ; but the deliberation which has characterized the few movements of the patient, and the calm and easy attitude of the dead body in almost every instance show that convulsions are either absent altogether or short and transient. 3. The question of the cumulative property of prussic acid is sometimes raised when a patient dies while taking a series of medicinal doses of the acid at such short intervals of time as a few hours. It is deemed probable that the previous doses have not been eliminated from the system, or spent their effect upon it, and that the addition of the last dose determines the fatal result. In the case of so volatile a poison, and one so readily eliminated by the lungs as well as by other organs of the body, it seems highly improbable that a medicinal dose, which is generally but a small fraction of the smallest fatal dose, or even a series of medicinal doses, would leave such a residual effect as to prove fatal to life on the addition of another medicinal dose. But doses that exceed the proper medicinal limit may happen to prove fatal, though similar previous doses have appeared to be harmless, in consequence of a change in the state of the body itself; for there is no doubt that the line which divides a harmless from a fatal dose is not very wide. Fortunately this question, so difficult of solution, is not one of great practical importance.

POISONING BY THE CYANIDES.

The cyanides of potassium and of mercury have proved poisonous, the latter with symptoms allied to those of poisoning by corrosive sublimate (see p. 419), the former with symptoms of poisoning by the acid itself.

Cyanide of Potassium.—This substance is now largely used in the arts, both in the process of electrotyping and in that of photography. It is employed to remove the stains of nitrate of silver from the hands, and to clean tarnished metal and gold and silver lace.

Properties.—This salt is sold as a white crystal or crystalline mass, which readily absorbs moisture, gives out a strong odour of prussic acid, and has a characteristic cold, bitter, pungent taste. It is very soluble in water; and its solution has a strong alkaline reaction.

Tests:—*a.* On the addition of an acid, the vapour of prussic acid is given off, which may be identified by its odour, and by the tests described at p. 453. *b.* It yields with a solution of nitrate of silver the white cyanide of silver. *c.* A solution of chloride of platinum throws

down the base. *d.* The liquid tests produce with the solution the reactions described at p. 452; but as the solution already contains potash, the addition of liquor potassæ is not required.

In *organic liquids* the poison may be detected by neutralizing the base with sulphuric acid, and immediately distilling over the prussic acid.

Symptoms.—This substance acts nearly with the rapidity and violence of prussic acid itself, and produces symptoms differing so little from those proper to the acid as to require no separate description.

Fatal Dose.—Less than five grains. From the composition of the cyanide, which contains nearly forty per cent. of the anhydrous acid, it is probable that about 2½ grains of this salt would destroy life.

Post-mortem Appearances.—Those proper to poisoning by prussic acid.

Treatment.—That of poisoning by prussic acid itself. As the cyanide of potassium is a strong local irritant, it should be applied to the hands to remove stains with caution, and used with similar care for manufacturing purposes.

3. VEGETABLE SUBSTANCES AND PRODUCTS CONTAINING, OR YIELDING, HYDROCYANIC ACID.

The leaves, seeds, or roots of several plants either contain prussic acid, or they yield it when bruised and moistened. The bitter almond, the kernels of the cherry, plum, and peach, and the pips of the apple, are examples of poisonous seeds; the leaves of the cherry laurel yield the poison on distillation, and the plant which yields tapioca (the *Iatropha manihot*, or cassava) contains prussic acid in the juice of the root. The bitter almond, and the oil and water obtained from it, and the distilled water from the cherry laurel, are particularly deserving of notice.

The bitter almond is distinguished, as its name implies, by its bitter taste. It forms with water a white emulsion, in which the essential oil blended with prussic acid is rapidly developed by the mutual action of two of its constituents, *emulsine* and *amygdaline*. The vapour from the emulsion acts characteristically with the tests for prussic acid. As the same change takes place in the stomach, bitter almonds cannot be eaten in large numbers without inducing symptoms of poisoning. The same result follows from eating the *bitter almond cake*, which remains after the expression of the fixed oil. But the essential oil, its alcoholic solution (almond flavouring), and bitter almond water, are active poisons, and have proved fatal. Of these three preparations the essential oil is by far the most important, as it is a very active, and has now become a very favourite, poison.

Essence or *Oil of Bitter Almonds.*—This is the product of the distillation of the pulp or emulsion of the bitter almond. It contains, in addition to hydrocyanic acid, hydride of benzole, benzoin, and benzoic acid. The hydrocyanic acid, to which it chiefly owes its poisonous properties, may be separated from it, and the essence thus purified, and rendered

comparatively harmless, is sold for culinary purposes. The essence, or oil, previous to this separation, contains from $8\frac{1}{2}$ to $14\frac{1}{2}$ per cent. of the anhydrous acid. It has, therefore, from four to seven times the strength of the acid of the Pharmacopœia. A liquid variously known as almond flavour, spirit of almonds, or essence of peach kernels, consists of the oil dissolved in seven or eight times its quantity of spirit.

Properties.—Ordinary specimens of the oil have the colour of amber, a peculiar, pungent odour, due in part to the prussic acid which it contains, and a bitter, aromatic taste. It is heavier than water, which dissolves only a small fraction of it; but it is soluble in alcohol and æther. It produces a greasy stain on paper, and it has a slight acid reaction. Strong sulphuric acid reddens it.

Tests.—Those of hydrocyanic acid. Pour a drop of the oil into a series of watch glasses, add a few drops of distilled water, and invert over them discs of glass moistened with the several tests (p. 453). The vapour acts more promptly when the glasses are warmed. Or, place a few drops of the oil in a test-tube, add a drachm of distilled water, mix them well by shaking; pour the mixture on a wet filter, and test the liquid that passes through as for dilute hydrocyanic acid. The odour of the oil is not a decisive proof, since a chemical compound known as nitro-benzole or nitro-benzine has a very similar odour.

Symptoms.—Those of poisoning by hydrocyanic acid (p. 457); but the symptoms do not appear to commence so soon, and the duration of the poisoning seems to be longer. The recorded cases present similar variety in the symptoms, and similar acts of volition occupy the interval between the swallowing of the poison and the commencement of the symptoms.

Post-mortem Appearances.—Those of poisoning by hydrocyanic acid (p. 458), the odour of the oil taking the place of the odour of the acid.

Treatment.—That of poisoning by hydrocyanic acid (p. 458).

Fatal Dose.—About twenty drops. As strong specimens of the oil have from four to seven times the strength of the hydrocyanic acid of the Pharmacopœia, and a less quantity of the acid than fifty minims has proved fatal, it is probable that as small a quantity as ten or twelve drops might destroy the life of an adult.

Duration.—From a few minutes to half an hour. It may destroy life as speedily as prussic acid itself.

Bitter-almond Water.—This water is distilled from the cake left after expressing the fixed oil from the bitter almond. It is found in the shops of very variable strength, and is quite unfit for medicinal uses. Some specimens are found to contain one per cent., others a quarter per cent.

It owes its poisonous property to the prussic acid which it contains; and responds to the tests for that poison (p. 452). The symptoms, post-mortem appearances, and treatment are those of poisoning by hydrocyanic acid (p. 457).

Laurel Water.—The leaves of the cherry laurel (*Prunus lauro-cerasus*) yield both a distilled water and an essential oil which have the same properties as the water and oil of bitter almonds, and were formerly employed for the same purposes. The quantity of the prussic acid in the distilled water is about a quarter per cent., and in the essential oil three and a quarter per cent. Other portions of the plant also yield the poison; but it is not contained in the pulp of the fruit. The cherry laurel water has proved fatal in more than one case; but the one which possesses the greatest interest is that of Sir Theodosius Boughton, poisoned by Captain Donellan in 1781.

Sir Theodosius Boughton, a healthy young man of twenty years of age, was in the habit of taking a laxative draught from the hands of his mother. On the morning of his death she observed, while giving him his draught, that it had a strong smell of bitter almonds. "Two minutes after he took it she observed a rattling or gurgling in his stomach; in ten minutes more he seemed inclined to dose, and in five minutes afterwards she found him quite insensible, with the eyes fixed upwards, the teeth locked, froth running out of his mouth, and a great heaving at his stomach, and gurgling in his throat. He died within half an hour after swallowing the draught." The body was carelessly inspected ten days after death, but the post-mortem appearances threw no light on the cause of death. The odour of the draught, the rapid occurrence of symptoms so closely resembling those present in recorded cases of poisoning by prussic acid, and the speedy death of the sufferer at an age when apoplexy is so rare, combine to leave no reasonable doubt of the real cause of death.

CHAPTER XV.

POISONING BY ALCOHOL, ÆTHER, AND CHLOROFORM.

THESE poisons have the common property of inducing a state of narcotism, often preceded by delirious excitement, and followed by indisposition, of which nausea and vomiting are generally the leading symptoms. In large doses, and in a concentrated form, they may destroy life suddenly by shock; but they generally prove fatal by inducing a state allied to apoplexy, or by paralyzing the heart. They act as irritants to the parts with which they come in contact, producing intense inflammation in the lining membrane of the stomach when swallowed, and in the lining membranes of the air-passages when inhaled. But they do not affect the whole tract of the intestinal canal, as do the poisons grouped under the class of narcotico-irritants.

1. ALCOHOL.

Alcohol, or spirit of wine, is the active ingredient of a great variety of intoxicating agents obtained from saccharine juices in a state of fermentation. By the distillation of such fluids, followed by rectification with charcoal, and a final distillation from quick-lime, *anhydrous* or *absolute* alcohol is obtained. This absolute alcohol, diluted with little more than its weight of water, constitutes *proof spirit*, which differs little in strength from the various *ardent* spirits distilled from wine, malt, molasses, or rice, flavoured and coloured with burnt sugar, juniper berries, and peat, and known respectively as brandy, whiskey, hollands or gin, rum, and arrack. The absolute alcohol in these ardent spirits varies from 51 to 54 per cent. Of the stronger wines it constitutes from 12 to 17 per cent.; of the lighter wines from 7 to 9 per cent., and of the stronger English malt liquors from 5 to 6 per cent.

Properties.—Pure alcohol is a colourless, volatile liquid of low specific gravity (0·815 at 32°), boiling at 173°, and not freezing at the lowest attainable temperature. It has an agreeable odour, and a burning, pungent taste. It is very inflammable, burns with a light-blue flame, and yields, as the products of its combustion, carbonic acid and water.

Tests.—*a.* When burned, it leaves no stain of charcoal. *b.* The products of combustion render lime-water or the solution of nitrate of baryta white and turbid. *c.* It dissolves camphor. *d.* When boiled with a saturated solution of bichromate of potash, mixed with sulphuric

acid, the green oxide of chrome is set free. This last test is recommended by Dr. Taylor ('On Poisons,' p. 728) as one of great delicacy; but it does not distinguish pure alcohol from æther or pyroxylic spirit.

In Organic Liquids.—The contents of the stomach in persons dying from the effects of large doses of spirituous liquors generally have the odour of the spirit; but there are exceptions to this rule. If they contain any spirit it may be separated by submitting them to the same process of distillation as is adopted in order to obtain anhydrous or absolute alcohol from fermenting saccharine substances. If the contents of the stomach have an acid reaction, they must first be neutralized by potash. The liquid resulting from the distillation may be identified by the tests just enumerated.

Alcohol is absorbed, and may be detected by its odour, and by tests applied to the products of distillation, in the blood and secretions, in the brain, and in other solid viscera.

Experiments on Animals.—From Sir Benjamin Brodie's experiments on rabbits with large quantities of proof spirits, it appears that symptoms of poisoning set in immediately or in a few minutes, and that death ensues in from about half an hour to an hour and a quarter. In one experiment in which two ounces of proof spirit were injected into the stomach of a rabbit, the injection was scarcely completed when the animal became perfectly insensible. It was apparently dead in twenty-seven minutes, but the heart had not ceased to beat. The symptoms produced in these experiments were complete insensibility, dilatation of the pupils, rapid pulse, laborious and stertorous breathing, and slight convulsions. The lining membrane of the stomach bore marks of great inflammation.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—After a period varying from a few minutes to an hour or more, according to the quantity and strength of the alcoholic liquid, the symptoms set in with confusion of thought, giddiness, imperfect or double vision, indistinct and stammering speech, uncertain and abrupt movements of the limbs, and a tottering and stumbling gait. At length the patient becomes speechless, motionless, and insensible, with a bloated and suffused countenance, injected eye, dilated and fixed pupil, livid lip, and slow and stertorous breathing. Recovery may take place after a prolonged sleep, or more abruptly by vomiting; or death may occur after an interval of several hours with symptoms of collapse, indicated by pallor of the face, cold sweats, quick and feeble pulse, and complete relaxation of the limbs. When very large quantities of ardent spirits are taken death may ensue almost immediately by shock. Sometimes insensibility sets in suddenly; sometimes as a sudden relapse after apparent recovery. Convulsions are among the occasional symptoms, and delirium tremens and raging incoherence are sometimes the result of a single debauch. The symptoms of poisoning by

alcohol nearly resemble, as has been shown by Sir Benjamin Brodie, those of concussion of the brain; they are also difficult to distinguish from the effects of severe cold and from those of poisoning by opium. In many cases the odour of spirits will assist the diagnosis. As a general rule, the pupils are dilated in poisoning by alcohol, and contracted in poisoning by opium, and the countenance which is flushed in the one case is pallid in the other.

Morbid Appearances.—The most constant appearance is a deep crimson or dusky red colour of the lining membrane of the stomach, sometimes extending upwards to the gullet and downwards to the commencement of the small intestines. In some cases there is dark extravasation under the lining membrane. In rare instances the stomach is inflamed only in patches: still less frequently there are no marks of inflammation in any part of the organ. Congestion of the brain, and of the air-passages, are among the less constant appearances.

Treatment.—The stomach-pump should be used without delay, and the cold affusion as a shock. The after treatment will depend on the state of the patient. If there is much congestion of the brain, blood may be drawn from the arm. If great difficulty of breathing, with a cold surface and feeble pulse, the treatment proper to apnœa may be required. In the last resort, galvanism may be employed.

Chronic Poisoning by Alcohol.—Drunkards suffer from functional and organic diseases of all the important organs of the economy: from indigestion, with vomiting and purging through irritation of the stomach and bowels; from jaundice through irritation of the liver; from albuminous urine, diabetes, and other urinary disorders through irritation of the kidney; from congestion of the brain, delirium tremens (see p. 159), and insanity; from paralysis, convulsions, and shaking palsy; as the effect of the poison on the nervous centres. The organic diseases induced by the prolonged abuse of spirituous liquors are fatty degeneration of the liver, kidneys, heart, brain, and spinal cord, scirrhus of the stomach, and pulmonary consumption. Dropsy is a common result of the organic diseases of the drunkard.

2. ÆTHER.

Several volatile and inflammable liquids are known to the chemist under the general name of *æther*, and they are divided into three groups under the titles of simple, double, and compound æthers. The liquid known as æther, ordinary æther, vinic æther, or sulphuric æther, belongs to the class of simple æthers, and is the poison here spoken of. It is the product of the distillation of a mixture of alcohol and sulphuric acid.

Properties.—Pure æther is a colourless liquid, highly volatile and inflammable, with a low specific gravity (0·724 at 55°), boiling at 95° and freezing at about —24°. It burns with a yellow flame, and deposits charcoal on cooled surfaces, but when burned with a proper proportion

of oxygen is resolved (like alcohol) into carbonic acid and water. It yields a dense, inflammable vapour, which forms with oxygen or air, in certain proportions, an explosive mixture. Its odour is penetrating and characteristic, and its taste hot and pungent, but on evaporation it gives a sensation of cold. It is sparingly soluble in water, but freely dissolves in alcohol. It is also a powerful solvent of a considerable number of bodies, among others the alkaloid strychnia.

Tests.—*a.* Its characteristic odour. *b.* Its imperfect combustion, leaving a stain of carbon on cool surfaces. *c.* Its being only partially dissolved in water, the bulk of the liquid floating on the surface. *d.* It has the same reaction as alcohol with bichromate of potash and sulphuric acid.

In Organic Liquids.—The process for separating æther from the contents of the stomach is the same process of distillation as for alcohol.

Experiments on Animals.—The experiments of Orfila show that æther produces nearly the same effect on animals as alcohol.

SYMPTOMS, MORBID APPEARANCES, AND TREATMENT.

Symptoms.—Large doses of liquid æther, such as several drachms, give rise to nearly the same effects as alcohol. A stage of delirious excitement is followed by narcotic symptoms.

The symptoms which follow the inhalation of the vapour show themselves more quickly, and are more severe than those which follow the swallowing of an equal quantity of the poison. The first effects of the vapour are seen in quickened pulse and respiration, flushed face, suffused eye, and excitement of the mind; but if the inhalation be continued, the patient falls into a state of stupor, with slow laborious stertorous breathing, and quick pulse. The face and lips are livid, the surface pale and cold, the pupil dilated and fixed, the eye turned upwards, and the whole voluntary muscular system relaxed. If the inhalation is carried on for a few minutes only, these symptoms soon disappear; but if it is continued for ten minutes, a quarter of an hour, or more, all the effects are increased, and the patient is roused with difficulty. When the effect of the poison is complete, sensation is suspended, so that long and difficult operations may be performed either without any evidence of pain, or with indications of suffering which leave no recollection behind them. The symptoms are not, however, uniformly such as are described above. The poison sometimes causes violent excitement; in other cases it produces a state of incoherence; in others, again, it irritates the lungs and gives rise to a troublesome cough; and nausea and vomiting either occur during the inhalation, or they are among the symptoms of recovery. The prolonged inhalation of the vapour may end fatally.

Morbid Appearances.—Those due to poisoning by alcohol. The

odour of æther perceptible in the contents of the stomach, and throughout the body.

Treatment.—That of poisoning by alcohol.

3. Chloroform.

Chloroform, or chloroformyl, is one of the large class of chemical compounds formed by substituting chlorine, bromine, or iodine for the hydrogen of the simple or compound æthers. It is procured by a process of distillation from a mixture of chloride of lime, alcohol, and water.

Properties.—Chloroform is a colourless liquid, of high refracting power, and high specific gravity (1·497). It is very volatile, giving out a dense vapour (sp. gr. 4·2). It boils at 142° F. It has a sweet pungent taste, and a strong pleasant æthereal odour compared to that of apples. It is perfectly soluble in alcohol and æther, but very sparingly soluble in water, in which it sinks in large globules. If pure it has a neutral reaction; it does not discolour oil of vitriol, has no odour of chlorine, and leaves no unpleasant odour on evaporation. It dissolves camphor, volatile oils, wax, resin, caoutchouc, gutta percha, and some of the alkaloids, among which strychnia is the most important in a medico-legal point of view. It also dissolves iodine, bromine, sulphur, and phosphorus. At a red heat its vapour is resolved into chlorine and hydrochloric acid.

Tests.—*a.* Its taste and odour. *b.* Its high specific gravity and sparing solubility in water. *c.* It is inflamed with difficulty, and burns with a green flame. *d.* It completely dissolves camphor, gutta percha, and caoutchouc. *e.* It produces its characteristic effects on small animals.

In Organic Mixtures.—Liquid chloroform may be separated from the contents of the stomach by a process of distillation at a temperature of 120° F. The vapour may be separated from the blood and tissues by the same process, or by one based on the fact that the vapour of chloroform is decomposed when transmitted through a tube heated to redness. (For details of this process, see Taylor, 'On Poisons,' p. 742.)

Symptoms, Post-mortem Appearances, and Treatment.

Symptoms.—Those due to poisoning by æther, but they set in more rapidly. The loss of sensibility is more complete, and the relaxation of the muscular system may extend to the sphincters. Death may take place suddenly from shock or syncope, in convulsions, or in an epileptic fit; and the fatal event may happen either during the inhalation, immediately after it, or at an interval of several hours, or of one or two days. Among the fatal cases (now amounting to more than fifty) there are many in which it is impossible to attribute the event to the impurity of the chloroform, or to the want of skill and

care in administering the vapour. The fatal event has been due in some cases to disease of the heart or brain; in others, probably, to the action of the poison combined with the shock of the operation.

The successive effects of chloroform have been distinguished by five distinct stages, namely:—1. A stage of exhilaration. 2. A stage of drunken drowsiness. 3. A stage of profound sleep, with contracted pupil. 4. A stage of perfect insensibility; and 5. A stage of coma, with slow breathing and dilated pupil. (Druitt).

Shortest Fatal Period.—Death may take place in less than two minutes from the commencement of the inhalation.

Smallest Fatal Dose.—The vapour from as small a quantity as fifteen drops of chloroform has proved speedily fatal. A drachm of liquid chloroform swallowed by a boy aged four proved fatal in three hours. (Taylor, 'On Poisons,' p. 740.) For a minute detail of the symptoms and post-mortem appearances in a case of poisoning by repeated doses of liquid chloroform, amounting in the aggregate to more than five ounces, consult the case of Dr. Glover, as described by Mr. F. J. Gant, 'Lancet,' April 23, 1859, p. 425. Death took place, in this instance, after 25 hours, in spite of judicious and persevering treatment. Consult also the able chapter on chloroform in the sixth edition of Druitt's 'Surgeon's Vade Mecum.'

Treatment.—Cold affusion as a shock, followed by the treatment proper to apnœa. In poisoning by liquid chloroform, the treatment should commence with the use of the stomach-pump.

CHAPTER XVI.

POISONING BY NARCOTIC GASES.

1. CARBONIC ACID, and other products of combustion.
2. SULPHURETTED HYDROGEN, and the gaseous contents of sewers and drains.
3. CARBURETTED HYDROGEN and coal gas.

THE most important of the narcotic gases are carbonic acid and carbonic oxide, sulphuretted hydrogen, and carburetted hydrogen. Cyanogen gas is also an active narcotic poison, and nitrous oxide, oxygen, and hydrogen appear to belong to the same class of poisons. But these gases have little medico-legal importance.

The narcotic gases, in a pure and undiluted state, may, like the irritant gases, act as asphyxiating agents, by causing spasm of the glottis, and thus excluding air from the lungs. When diluted with atmospheric air, they destroy life by affecting the brain and nervous centres. It is in this state of dilution with atmospheric air, as well as of admixture with other gaseous poisons emanating from the same sources, that these gases will have to be examined.

1. CARBONIC ACID GAS.

Carbonic acid gas is generated in many different ways. It is the principal product of the combustion of fuel; it is given out largely in the process of fermentation, and in the burning of lime; animals expire it as a product of respiration, and plants exhale it freely at night; and it collects in mines, caves, coal-pits, graves, and wells. From the inhalation of the gas produced in any of these ways fatal accidents have occurred.

The question of accident, suicide, or homicide, is rarely raised in cases of poisoning by this gas. The place in which a body is found, and the surrounding circumstances, are generally decisive as to the cause, which, in the majority of cases in this country, is accidental. It is very rarely employed here as a means of committing suicide, though the practice is very common in France; and it is not likely to be made use of by a murderer, though Devergie has related some cases which seem to justify the suspicion that it has been so employed.

But though the cause of death in poisoning by carbonic acid will generally be inferred from the place and circumstances in which a body is found, suspicions of foul play have been ignorantly entertained; and

the dangerous or fatal results have been attributed to mechanical suffocation, as in a case related in the Reports of Ambrose Paré, or to some poison administered by the mouth, as in a case cited by Christison.

Occasionally the true state of things is not suspected, until several persons have suffered or perished. This happens when the wood-work of houses is carbonized by heated flues, or when the products of combustion make their way from one apartment into another.

Properties.—Carbonic acid is a colourless, inodorous gas, much heavier than atmospheric air, with which it mixes slowly. It is soluble in water, and has the reaction and other properties of an acid. It combines with lime to form chalk.

Tests.—*a.* It produces a milkiness, followed by a white precipitate, in lime water. *b.* It does not support combustion; and when mixed with air, in the proportion of from ten or twelve to fifteen or twenty per cent., it extinguishes flame. A small feeble flame is extinguished by as little as ten or twelve per cent. *c.* Litmus paper moistened with bleaching liquid is first reddened, and then bleached by the gas as it exists in the air.

The property which carbonic acid has of combining with lime is turned to practical account in purifying the air of wells or pits. A vessel of lime, mixed up with water into a thin paste, is lowered into the stratum of gas. But the same result may be obtained by a current of air or jet of steam.

Quantitative Analysis.—The quantity of carbonic acid in the air may be determined by the amount of absorption which takes place in a graduated jar containing liquor potassæ. The gas may be collected for analysis by emptying a full jar of water into the space containing it. The quantity of charcoal which has been burned in any case may be estimated at twenty or twenty-five times the quantity of ash remaining.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—Carbonic acid gas, pure and unmixed, acts as an irritant, and causes a spasm of the glottis, and death by apnœa. In a state of dilution, and either pure or mixed with other products of combustion, it may be breathed for a considerable period; and it produces symptoms varying in intensity with the quantity of the gas. The character of the symptoms will also be modified by the gases with which it may happen to be mixed. When mixed with the more active carbonic oxide, the narcotic symptoms are more urgent; the sulphurous acid gas, which is given off during the combustion of coal, acts as an irritant to the organs of respiration; and other modifications may arise from the admixture of carburetted hydrogen, or of other hydrocarbons.

The ordinary symptoms of poisoning by carbonic acid are: a sensa-

tion of weight in the forehead and back of the head, and of tightness in the temples, violent headache, giddiness, ringing in the ears, dimness of sight, drowsiness, hurried respiration, and violent palpitation, nausea, and, in many cases, vomiting; followed by complete insensibility, stertorous breathing, slow pulse, and pallor and lividity of the surface. Death may be due to apoplexy, or to apnœa. Sometimes a deep sleep terminates in death. Occasionally the sensations seem, as in drowning and hanging, to be pleasurable. In a few cases the symptoms have set in with delirium. Convulsions and tetanic spasms are of occasional occurrence.

Post-mortem Appearances.—The body is generally swollen, and marked more or less extensively with livid spots, and the limbs are frequently rigid, and the abdomen distended with air. The countenance is, in some cases, pale and composed, in others livid and bloated; and the eyes are bright and prominent. Froth, or froth tinged with blood, is sometimes found about the mouth and nostrils; and the tongue is sometimes protruded between the teeth. The animal heat is retained longer than usual, cadaverous rigidity is slow to show itself, and putrefaction is retarded. Internally the body presents the following appearances: the large veins and the right cavities of the heart are gorged with black blood, and the lungs and lining membrane of the air-passages are congested. The brain and its membranes are injected, and the veins and sinuses distended. Serum is found in the ventricles, and at the base; and effusions of blood on the surface of the brain or into the ventricles are of occasional occurrence. The base of the tongue is injected, and ecchymosed patches are sometimes found in the alimentary canal.

Some of these appearances bear a close resemblance to those present in cases of death by apnœa, but the turgescence of the brain is much more remarkable in cases of poisoning by carbonic acid than in fatal cases of apnœa from other causes; and it has been proved experimentally that carbonic acid gas does not act as a mere asphyxiating agent, but as a specific narcotic poison.*

* As the value of some of the post-mortem appearances was a subject of lively controversy in the case of James Trickey, given in the text, the following particulars are subjoined from a valuable paper by the late Dr. Golding Bird—('Guy's Hospital Reports,' vol. viii. p. 75.)

The *expression of countenance* in twelve cases in which it is described, was pale and calm in 5 cases; bloated in 7. *Vomiting* had occurred in 3 cases, and was absent in 5 in which that symptom was noticed. There was *froth at the mouth* in 6 cases; it was absent in 4. There was *froth and serum* at the nostrils in 4, and they were lined with black mucus in 2. The *eyes* were injected in 2; dilated, prominent, and shining in 3; closed and dull in 3. The *limbs* were rigid in 5; flexible in 2. The *tongue* was protruded and grasped by the teeth in 6; drawn in and concealed in 2. There were livid patches on the skin in 10 cases; they were absent in 2. The *abdomen* was distended with air in 9; not distended in 4. The *membranes of the brain* were injected with blood in 8, and described as congested in 4; there was serous effusion beneath the arachnoid in 3. The *vessels and sinuses* were turgid in all the cases in which those parts are mentioned. The *blood* was not always of the same colour. There

Treatment.—This consists in the prompt removal of the patient to a pure air, the use of cold affusion as a shock, and, where the countenance is bloated and livid, of general or local blood-letting. Artificial respiration, galvanism, and the inhalation of oxygen gas may be resorted to in extreme cases. Frictions and warmth to the surface are indicated, as in cases of apnœa.

Preventive Measures.—The prevention of accidental poisoning by carbonic acid must rest in a great degree on the possession on the part of the public of correct information respecting the nature of combustion and of its products, and of the situations in which accumulations of carbonic acid gas are most likely to take place. The fact that stoves heated by charcoal in the open air of rooms, and giving out carbonic acid into the atmosphere, are still used by persons of education, shows how little scientific knowledge such persons may possess. It may be well, when speaking of preventive measures, to correct an error into which even intelligent and educated persons are liable to fall, that it is safe to breathe an atmosphere in which a candle continues to burn. It should, on the contrary, be understood that a candle may burn in an atmosphere which will speedily prove fatal to life; while, on the other hand, a man may for a short time breathe with impunity an atmosphere in which candles are extinguished. Thus, Mr. Coathupe cites a case that occurred in his own neighbourhood, of a man who descended into an abandoned coal-pit, in which ignited candles were repeatedly extinguished, and remained in it for several minutes, until he succeeded in bringing to light the body of a child, who had fallen from a part of the old machinery.

In a case mentioned by M. Marye, and quoted by Devergie, a candle was extinguished in an atmosphere that produced only a slight sensation of uneasiness in a gentleman who made an abortive attempt at suicide. In another and successful attempt, a candle was found burning on the table, whilst he was lying dead on the floor. In the former instance, the candle was probably below the level of the body, in the latter it was above it. ('Annales d'Hygiène,' vol. xxiii. p. 190.)

Several interesting and practically important questions connected with poisoning by carbonic acid require examination. Some of these are set forth in the following case, which, at the time of its occurrence, excited a lively interest, and gave rise to much discussion.

James Trickey, aged 66, watchman and steeple-keeper of St.

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was *no effusion of serum* on the brain in 6 cases. *Serous effusions* in 3 cases. The substance of the brain was injected in 8. Blood was effused on the surface in 1; the brain was in its natural condition in 2. Serum in the *ventricles of the brain* in 6; absent in 3. Blood was effused into them in one case.

Among the post-mortem appearances on which the greatest stress has been laid is the rosy or livid discoloration of the skin. Devergie places great reliance upon this sign. The long continuance of animal heat, and rigidity, and the slow progress of putrefaction, are also points which have been much insisted on. ('Annales d'Hygiène,' vol. xvii. p. 225.)

Michael's Church, Cornhill, was placed in the church, on the night of Nov. 17, 1838, in charge of a stove heated by charcoal (one of Harper and Joyce's patent apparatus). He entered the church at eleven o'clock at night, and the next morning he was found dead, lying on his face, with his feet about three feet from the stove, and his head lower than the rest of his body, the trunk resting on a step. A considerable quantity of vomited food was found on the floor near his mouth. The church was so full of some vapour that the respiration of the persons who first entered in the morning was considerably affected. The principal post-mortem appearances were as follows: The countenance calm and composed, and the eyes lustrous. The vessels of the brain gorged with fluid blood; considerable serous effusion between the arachnoid and pia mater, and at the base of the brain; numerous bloody points in the substance of the brain. The lungs almost black, the vessels turgid with blood, the trachea containing a frothy mucus, and the lining membrane injected; the blood in the large veins dark, but fluid; the stomach nearly full of undigested food. Every other part of the body healthy.

At the inquest, considerable difference of opinion existed among the medical witnesses as to the cause of death. They all agreed that he had died of apoplexy, but some thought this mode of death was sufficiently explained by his advanced age, by his apoplectic make, and by the full meal which he had taken before he commenced his watch in the church. Others, on the contrary, though they likewise attributed the death to apoplexy, attributed the apoplexy itself to the inhalation of carbonic acid.

The question to be decided, therefore, ultimately took this shape: Was there a sufficient quantity of carbonic acid in the church to account for the man's death; and supposing the quantity diffused through the church not to be sufficient to account for the fatal event, might not the part in which he lay (for he was on the floor close to the stove) contain a sufficient quantity of the gas to prove fatal? As similar cases, involving similar questions, may again arise, it may be well to say a few words on each of these two points.

1. What is the smallest quantity of carbonic acid diffused through the air that may prove fatal?

2. Is the carbonic acid produced in the burning of fuel in rooms or buildings equally diffused, or does it accumulate in one part of the apartment more than in another?

1. In estimating the quantity of carbonic acid required to destroy life, it ought to be borne in mind that when the gas is the product of respiration or combustion it is formed at the expense of the oxygen of the air; so that the air is rendered less fit for the support of life by the withdrawal of a vital element, as well as by the addition of a poison. The different susceptibility of persons of the two sexes and different ages should also be considered (see p. 227). Some light is thrown on this question by the experiments of Allen and Pepys, which

have shown that air once inspired becomes charged with from 8 to 8½ per cent. of carbonic acid, and that, however often it may be respired, it never acquires more than 10 per cent. As fatal consequences have more than once ensued from simple overcrowding, when the pollution of the air, in all probability, fell far short of this limit, we may safely assume that a quantity of carbonic acid much less considerable would destroy life. Devergie thinks that five per cent. is sufficient, but Mr. Coathupe ('Lancet,' vol. xxxi. p. 201) states that he suffered most severely from inhaling an atmosphere containing, at the outside, according to his own calculation, 2 per cent.

In the case of St. Michael's Church, it appears that the contents of the building were 110,000 cubic feet, and the quantity of carbonic acid which might have arisen from the charcoal employed was 1500 cubic feet; so that little more than 1⅓ per cent. of the gas could have been diffused through the building, a quantity probably much smaller than that contained in crowded and ill-ventilated rooms, especially when lighted by gas, and probably too small to destroy life, though breathed by a sleeping man for several hours in succession. The death of James Trickey could not therefore be attributed to the inhalation of carbonic acid, on the supposition that the gas is uniformly diffused through the air of the building. But if, as some believe, and as the experiments of Devergie seem to prove,* the carbonic acid is unequally distributed, and, when the temperature of the apartment has become the same in every part of it, subsides to the floor, the death of James Trickey, who lay on the floor of the church within three feet of the stove, was probably due to the poisonous gas which he inhaled. But in order to explain the death of James Trickey by carbonic acid, it is not necessary to assume this subsidence of the gas to the lower part of the building; for except in those cases in which this heated gas given off from the burning fuel rises in a column of air to escape by a vent in the ceiling directly above it, the gas will doubtless be diffused in larger quantity through the air immediately surrounding the stove, whether above it, around it, or beneath it; and if the air of the apartment, instead of being assumed to be still, is subject to drafts, the gas would be carried in the direction of the draft, so as to increase the danger of a person exposed to it. If the draft, however, be strong, it will clear the air of the carbonic acid which it contains, and free those who may happen to be in the current from all danger. This circumstance is illustrated by a case reported by Dr. Golding Bird, which also seems to place, beyond all reasonable doubt, the greater immediate accumulation of air in the proximity of the stove, than in the remoter parts of an apartment. This subject requires, and would well repay a careful investigation.†

* These experiments derive some confirmation from a case quoted by Devergie from a work by M. Marye, for which the reader is referred to the first edition of this work.

† 'Guy's Hospital Reports,' vol. viii. p. 84.

That such a diffusion of the gas does happen may be ascertained by placing lime water in watch-glasses, in different positions, about the source of supply. It becomes rapidly coated with a film, of about equal thickness, in whatever position it is placed. This equal diffusion of the gas is the more probable explanation of the death of James Trickey, assuming that his death was due to the inhalation of carbonic acid.

Meanwhile it may be useful to subjoin a short summary of the more obvious causes of an unequal distribution of carbonic gas, or of other products of combustion.

1. Carbonic acid may be generated (as in beer-vats) in an enclosed space, and form a stratum of gas above the source of supply, at the same time that it mixes very slowly with the atmospheric air above and around it. 2. Carbonic acid may enter an enclosed space (such as a well, cavern, or grotto,) from openings in the floor. In this case too, if the air of the upper part of the space be renewed by strong currents of air, or by the occasional opening of a door, the lower stratum of air may be poisonous, while the upper strata are comparatively pure. 3. Carbonic acid may be generated in an apartment by combustion, and rise as a compact column of heated air to a vent in the ceiling; or it may be drawn towards an open chimney; or, again, it may be forced into a particular direction by drafts or currents of air. 4. In an apartment without chimney, or other vent, and with no currents or drafts of air, or only very feeble ones, the gas will be diffused abundantly, though unequally, around the source of supply.

Other products of combustion.—Carbonic acid gas, though it is the chief, is not the only, product of the combustion of charcoal or coal. In the case of burning charcoal, the gases given off vary according to the rapidity with which the fuel is consumed. According to Orfila, the gas from dimly burning charcoal consists of 14 parts of carbonic acid and 14 parts of carburetted hydrogen, mixed with 52 parts of nitrogen and 20 of atmospheric air; while the products of vivid combustion are 12 parts of carbonic acid, mixed with 39 of nitrogen and 49 of atmospheric air.

Well-burned charcoal, therefore, yields little or no carburetted hydrogen; but it gives off, in variable quantity, a gas, not mentioned in this statement of M. Orfila, viz. carbonic oxide. This gas is a most active narcotic poison.

Where, then, combustion goes on slowly, a much larger quantity of air is deprived of its oxygen than when combustion is vivid.

The gases given off in the smothered combustion of coal are of a much more compound nature than those produced from charcoal. In addition to carbonic acid, we may expect to find sulphurous acid gas, and the sulphuretted and carburetted hydrogen gases. These gases are also highly injurious to life.

2. SULPHURETTED HYDROGEN (*Hydro-sulphuric Acid*).

This gas ranks next in importance to carbonic acid. It is scarcely less generally diffused, but being of a most offensive odour it gives warning of its presence. It is an extremely active poison, for according to Thénard atmospheric air, which contains $\frac{1}{1500}$th of its volume will destroy a bird; when it contains $\frac{1}{800}$th of its volume it will kill a dog; and $\frac{1}{250}$th proves fatal to a horse. Injected into the blood, it speedily destroys life; and it also proves fatal when introduced into any of the cavities of the body, or even when applied to the unbroken skin.

Properties.—This gas is characterized by a peculiarly offensive odour—that of rotten eggs. It is also remarkable for the variety of its reactions with the metallic bases. It combines with ammonia to form the sulphide of ammonium, which has a similar offensive odour added to the pungency of hartshorn, and similar chemical reactions. The presence of ammonia is indicated by the fumes given out when a rod dipped in hydrochloric acid is held in the gas.

Tests.—The usual test for this gas is acetate of lead, with which it gives a black precipitate. Filtering paper moistened with a solution of the salt of lead is a very delicate test for the gas. It is turned brown or black according to the quantity of the gas.

Symptoms.—When the gas is breathed in a moderately diluted state, it produces giddiness, a sensation of tightness across the temples, and of oppression in the pit of the stomach, nausea, sudden weakness, and loss of sense and motion. Tetanus, delirium, and convulsions, a cold skin, an irregular and very frequent pulse, and laborious respiration, are occasionally present.

Post-mortem Appearances.—The body has a highly offensive odour, and undergoes very rapid decomposition. The muscles are dark, and insensible to the stimulus of galvanism. The large vessels and all the internal viscera are distended with black liquid blood.

Treatment.—The means to be adopted for resuscitation are removal to a pure air, the use of stimulants, and the respiration of *chlorine* gas as given off from bleaching powder moistened with a dilute acid, or from any of the bleaching liquids. As chlorine is a powerful irritant it should be administered in a state of dilution with atmospheric air.

The sulphuretted hydrogen gas rarely exists in a separate state as a poison; it is most commonly met with combined with other gases in the soil of privies, cesspools, and common sewers.

Feculent matter in a state of putrefaction gives rise to three principal gases—sulphuretted hydrogen, sulphide of ammonium, and nitrogen. The first two are exceedingly deleterious, the latter possesses negative properties. These three gases may exist separately or combined in the soil of privies.

Sometimes it happens that no disagreeable odour is given out; neither the nauseous odour of the sulphuretted hydrogen, nor the irritating

and pungent odour of the sulphide of ammonium, but still the air is contaminated. In these cases the gases consist of carbonic acid and nitrogen, with a very small proportion of oxygen.

The symptoms and post-mortem appearances produced by the gases taken collectively will not differ much from those which are due to the inhalation of sulphuretted hydrogen alone. The rapidity with which the symptoms take place will depend on the degree of dilution or concentration of the gas. The most remarkable symptoms produced in those who have been suddenly and strongly affected and subsequently recovered, are, a feeling of violent pressure at the epigastrium, and round the head. Those who are employed in emptying the common sewers in Paris are frequently affected in this way.

Chlorine is the best substance to employ for the purification of the air from these gases, as well as for the recovery of persons asphyxiated by them.

The gases arising from the stagnant water of sewers are similar to those given off by privies and cesspools; but the gases as they form are partly held in solution by the water. In sewers with a good fall and liberal supply of water no gases are given off; but there is a peculiar animal odour due to their feculent contents. This odour does not appear to exercise any injurious effect on the health of men who work in sewers.

3. CARBURETTED HYDROGEN.

The chief constituent of coal gas is the combination of carbon and hydrogen known as light carburetted hydrogen, sub-carburetted hydrogen, marsh gas, or fire damp. In coal gas the light carburetted hydrogen is mixed with olefiant gas, and unless of unusual purity contains several other gases, such as ammonia, sulphuretted hydrogen, carbonic acid, and carbonic oxide, with free hydrogen and nitrogen.

Properties.—These mixed gases have a peculiar and offensive odour. They burn with a yellowish-white flame, yielding, as the products of combustion, chiefly water and carbonic acid, and forming, with certain proportions of atmospheric air, a dangerous explosive mixture.

Coal gas does not constitute so active a poison as carbonic acid and sulphuretted hydrogen; but when mixed with an equal bulk of atmospheric air it cannot be breathed without producing very serious effects upon the system. If greatly diluted with air no bad effects follow, as is proved by the fact that men who work in coal mines are rarely incommoded by it.

Symptoms.—Very few cases of poisoning by coal gas, or its principal constituents, are recorded. From a case described by Devergie, it appears that foaming at the mouth, vomiting, violent convulsions, tetanic spasms, stertorous respiration, and injection of the countenance, with dilated pupil, are amongst the most prominent symptoms.

Post-mortem Appearances.—From two cases reported by Mr. Teale

in the 'Guy's Hospital Reports,'* it seems that the principal morbid appearances are the following:—Pallor of the integuments, and of the internal tissues generally, with the exception of some portions of the mucous membrane; florid discolouration of the neck and back; light florid colour of the muscles; absence of all indications of venous congestion; fluidity of the blood, which is of a florid colour; infiltration of the lungs; injection and ecchymosis of the small intestines, and of the air-passages. Rigidity rapidly supervenes.

Treatment.—This consists in prompt removal into the fresh air, and the cold affusion, followed by the use of diffusible and other stimulants.

* No. viii., p. 106.

CHAPTER XVII.

NARCOTICO-ACRID POISONS.

This third division of narcotico-acrid or narcotico-irritant poisons consists, with few and insignificant exceptions, of substances derived from the vegetable kingdom—of the leaves, berries, seeds, and roots of plants, with their juices and the alkaloids, or other proximate principles, obtainable from them.

This group or division comprises many distinct poisons; in which respect it resembles the irritant and differs from the narcotic group. But these poisons are so rarely taken or given, that whereas on the average of the five years 1852 to 1856, out of 268 ascertained poisons, 175 were narcotics and 90 irritants, only 3 belonged to the class of narcotico-acrids. But though thus rarely administered in comparison with the members of the other two classes, most of the narcotico-acrids have been taken often enough to enable us to generalize their effects, and to describe the symptoms and morbid results which they produce.

The symptoms occasioned by the narcotico-acrids are partly due to certain vegetable alkaloids or principles which admit of separation, and partly to the vegetable matters that form the bulk of the plants, or parts of plants, from which those alkaloids or principles are procured. It is probably chiefly, if not wholly, to these active principles that the members of this class owe their peculiar and characteristic remote effects on the nervous centres, while their local irritant action is mainly due to the vegetable structures which constitute the bulk of the plants themselves. It should also be understood that this local action is not so severe as of itself to prove fatal to life; that it is not of constant occurrence; and that when the poison is taken in large quantities, it is often masked by the narcotic effects. The two classes of symptoms sometimes coincide, but sometimes the one precedes or follows the other.

The appearance of the plants belonging to this class is, for the most part, highly characteristic. The majority belong to the two natural orders, *solanaceæ* and *umbelliferæ*. The several portions of the plants themselves, as the leaves, roots, berries, and seeds, are often found in the alimentary canal, or in the matters rejected from the stomach or passed by the bowels, so as to be readily identified; and the odour and taste, or the impression produced upon the sentient nerves of the tongue and lips, are, in the case of more than one of them, in the

highest degree characteristic. The alkaloids themselves have the odour and taste of the plants from which they are extracted. *Strychnia* has the intense bitterness of nux vomica, *conia* the peculiar odour of hemlock, and *aconitina* produces the singular tingling of the lips and tongue which results from chewing the leaves, seeds, or root of aconite. The most important of the alkaloids (strychnia) has many characteristic chemical reactions, and is so permanent that it may be detected in the fluids and solids of the body. But the greater number of the alkaloids are less stable and less easily distinguished by chemical reagents, and we are consequently indebted to experiments on small animals for our best means of identifying them.

The *symptoms* common to the entire class of the narcotico-acrids, are heat and dryness of the throat with thirst; pain in the stomach with vomiting and purging; and delirium and spectral illusions, with dilated pupil. Convulsions; tetanic spasms and heightened sensibility; paralysis of the motor and sensitive nerves; coma and syncope; are among the less general symptoms.

Great difference in degree, and strange varieties in the combination of these elements, are observed in different cases of poisoning by the same substance, or by different substances.

Post-mortem Appearances.—Inflammation or congestion of the stomach and bowels, and congestion of the brain and its membranes, are the most common appearances after death; but they are not constant; nor are they sufficiently well marked to be decisive as to the cause of death.

Treatment.—If the poison has been swallowed in the form of leaves, roots, berries, or seeds, the first part of the treatment will consist in the use of emetics of sulphate of zinc, mustard, or salt, so as to empty the stomach. If the stomach-pump is at hand it is to be preferred. A full dose of castor oil mixed with hot milk should then be given with a view to discharge such portions of the poison as may have passed into the alimentary canal. At a later period clysters may be used with advantage. If the poison has been taken in the form of alkaloid, animal charcoal suspended in water should be first given, and should be followed, after a short interval, by emetics or the stomach-pump. As the alkaloids are precipitated both by tannic acid and by a solution of iodine in iodide of potassium, either of these may be substituted for animal charcoal, the tannic acid in the form of a decoction of oak bark, or of gall nuts, of the tincture of galls, catechu, or kino; or of a strong infusion of black tea; the iodine in a weak solution containing six grains of iodide of potassium and three grains of iodine in sixteen ounces of water (Bouchardat, as cited by Dr. Taylor, 'On Poisons,' p. 804). The after treatment will be determined by the prevailing symptoms of each case. If symptoms of collapse are present, the cold affusion should be administered as a shock, followed by diffusible stimulants; if symptoms of narcotism, the patient must be treated as if opium had been taken (see p. 447); if great irritation of

the alimentary canal should happen to be present, demulcents should be largely given, as in poisoning by the irritants; and in case of tenesmus and dysuria, emollient clysters. If the symptoms are such as to indicate the propriety of bleeding, the use of the lancet is to be commended as a means of removing part of the poison which has been absorbed. But, as a general rule, venæsection and the use of depressing emetics, such as tartar emetic and ipecacuanha, are objectionable, as tending to promote absorption. Bleeding should in no case be resorted to until the stomach has been emptied by emetics or the stomach-pump.

Hitherto the group of narcotico-acrids has been treated as consisting of individual poisons having certain characters in common. It is now necessary to deal with this group, as has been done already with the irritants and narcotics, as consisting of certain subordinate groups characterized by certain symptoms in common. One well-defined class consists of the plants which yield strychnia as their active principle—a class characterized by the powerful effect produced on the reflex function of the nerves of voluntary motion and sensation, in the shape of tetanic spasm, and heightened sensibility of the surface. The mind is generally unaffected. A second class is characterized by the very general occurrence of delirium, and illusions of the senses, associated with great dilatation of the pupil. This class comprises belladonna, hyoscyamus, stramonium, and camphor. A third class is equally characterized by the general occurrence of syncope or collapse, without delirium. This class comprises aconite, digitalis, tobacco, lobelia inflata, and hemlock; and in this class, too, the mind is usually unaffected. The remaining members of the class are chiefly remarkable for occasioning violent irritation of the alimentary canal with nervous symptoms not sufficiently defined or ascertained to justify their admission into the three classes just described.

The following classification of the narcotico-irritants will be adopted:—

1. Strychnia and the plants which yield it.
2. Belladonna, hyoscyamus, stramonium, and camphor, with the œnanthe crocata, cocculus indicus, lolium temulentum, and poisonous mushrooms.
3. Aconite, digitalis, tobacco, lobelia inflata, and hemlock.
4. The ergot of rye, cicuta virosa, phellandrium aquaticum, æthusa cynapium, cytisus laburnum, and solanum nigrum. lathyrus sativus.
5. Oil of turpentine, kreasote, oil of tar, and oil of dippel.

CHAPTER XVIII.

NUX VOMICA AND STRYCHNIA.

THE alkaloid strychnia is the chief active ingredient in several plants which have the common property of giving rise to symptoms similar to those of tetanus. It is generally found with another alkaloid, brucia, possessed of similar, but less active, poisonous properties.

Strychnia is ascertained to be the active poisonous principle of five plants—the Strychnos nux vomica, S. Ignatia, S. tieuté, S. toxifera, and S. colubrina. All these plants are natives of hot climates. The Strychnos nux vomica grows as a tree in Coromandel, in other parts of India, and in Ceylon; the S. Ignatia in the Philippine islands, also as a tree; the S. tieuté in Java, as a large climbing shrub; the S. toxifera is a native of Guiana; and the S. colubrina grows as a tree in many parts of Asia.

The S. nux vomica yields the poisonous seed and bark in use in this country; the S. Ignatia produces the seed known as the bean of St. Ignatius; the S. tieuté supplies the bark of which an aqueous extract constitutes the upas poison; the S. toxifera was until lately the reputed source of the poison variously designated as woorara, woorali, oorara, curara, and ticunas, and used by the natives of South America in preparing their poisoned arrows. There is now reason to believe that this poison is a compound derived from several sources (animal and vegetable). The curara as thus prepared, as well as the upas antiar (from the Japanese tree the Antiaris toxicaria), and the poison nut of Madagascar (the produce of the Tanghinia venenifera) act on the heart and brain, and not on the spinal cord. For more minute details respecting these poisons, the reader is referred to works on Toxicology.

There are three vegetable productions more or less common in England which contain strychnia—the bean of St. Ignatius, and the bark and seed of the Strychnos nux vomica.

The *beans of St. Ignatius* are not often met with out of museums. They are the seeds of the pear-shaped fruit of the S. Ignatia, in which they exist to the number of about twenty. They vary in size from that of a nut to that of a large filbert. They have a thin brown outer coat, which is easily detached, and leaves a smooth, black surface. They are very hard, and have the appearance of small pebbles with irregular shaped and rounded outline, and two or three unequal flattened surfaces. They contain strychnia in the proportion of 12 parts in 1000, and some brucia, and produce the same effects as nux vomica or strychnia.

The *bark of the Strychnos nux vomica*, formerly mistaken for cusparia or angostura bark, and named, accordingly, 'false Angostura bark,' has a very characteristic appearance. It is quilled, or twisted like dried horn, and is thickly covered with white prominent spots bearing some resemblance to a lichen. It yields a light yellow powder, which has an intensely bitter taste, and is reddened by nitric acid. It contains both strychnia and brucia, and acts upon the system in the same manner as the seed or the alkaloid.

The nux vomica, or seed of the S. nux vomica, is much more important than the foregoing, and requires to be more minutely described.

NUX VOMICA.

This poisonous seed is imported into this country in large quantities; and the seed itself, a powder prepared from it, and a spirituous extract (the extractum nucis vomicæ of the London and Edinburgh Pharmacopœias), as well as the alkaloid strychnia and its salts, are in common use as a poison for wild animals, rats, and vermin; and it is prescribed as a medicine in paralytic affections, and in some other diseases to which it would seem less applicable. In the two years 1837-8, nux vomica was the cause of death in three instances.

These seeds are enclosed in a rich orange-coloured fruit of the size and shape of a large apple, each fruit containing from three to five seeds. The seeds are circular in outline, vary in size and thickness from that of a shilling to that of a florin, and weigh from less than one scruple to more than two scruples. Their edges are rounded; one surface is concave, and the other convex, or convex in the centre and deeply grooved near the margin as in fig. 54. A horizontal section has the appearance shown in fig. 55, and a vertical section displays a circular

Fig. 54.

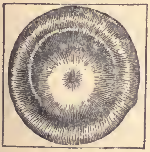


Fig. 55.

Fig. 56.

central cavity and heart-shaped embryo, as in fig. 56. By introducing a sharp knife at the projecting point shown in fig. 54, the seed may be easily cleft in two so as to display the embryo. The seeds have an external coating of light brown silky hairs, radiating from the centre, but the bulk of the seed is white, or of a light slate colour, and has a waxy appearance. The texture of the seeds is so hard that it can only be reduced to powder by rasping or filing. When turned in the

lathe they yield a white shaving like hartshorn. The interior portion of the seeds assumes a rich orange colour when touched with nitric acid, and is tinged green by the perchloride of iron.

The powder of the seeds has the colour of jalap powder, a faint odour, and an intense and persistent bitter taste. The brown silky fibres which form the coating of the nut are seen in large numbers under the microscope, and are very distinctly defined when treated with a drop of strong nitric acid. They have the appearance shown in fig. 57. Its watery solution is rendered pink by nitric acid, and green by the perchloride of iron. The powder contains the alkaloids strychnia and brucia in union with strychnic or igasuric acid. The quantity of the alkaloid strychnia has been variously estimated at 4 and at 10 parts in the 1000.

Fig. 57.

The extract of nux vomica is readily recognized by the rich orange colour imparted by nitric acid, the lake colour developed by sulphuric acid, and the transient blue tint given by sulphuric acid and bichromate of potash.

Symptoms.—Those of poisoning by strychnia.

Post-mortem Appearances.—Those of poisoning by strychnia. The brown powder often adheres to the lining membrane of the stomach.

Treatment.—The poison to be removed by emetics or the stomach-pump. The rest of the treatment that of poisoning by strychnia.

Fatal Dose.—Thirty grains of the powder, or the weight of a nut of medium size, and three grains of the alcoholic extract, have proved fatal.

Commencement of Symptoms.—From ten to forty minutes, or an hour.

Fatal Period.—From fifteen minutes to three hours or more. One hour is a common period.

STRYCHNIA.

This alkaloid is now in very general use in every part of the world for the destruction of wild animals and vermin. In poisoning wild animals it is usual to insert the strychnia into the stomach of a small animal or bird recently killed; and in poisoning birds, to steep grains of wheat in a strong solution of the alkaloid, or of one of its salts. A powder known as "Battle's Vermin Killer" contains, according to an analysis by Dr. Letheby, 23 per cent. of the poison mixed with flour, sugar, and Prussian blue. The flesh of animals that have eaten of poisoned meat or grain sometimes proves poisonous to other animals.

Strychnia and its salts are also used as medicines, and in consequence of this twofold use, cases of accidental poisoning occasionally occur. Of late years, too, the alkaloid has become a formidable instrument of death in the hands of the murderer; and is believed to have been the immediate cause of death in more than one recent instance, as in the cases of Palmer and Dove.

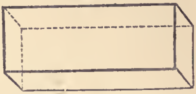
From the Report of the Registrar-General it appears that on an average of the five years 1852-56 strychnia and nux vomica are credited with 2 out of the 268 deaths by ascertained poisons.

Strychnia may have to be examined, 1. in substance, 2. in solution, 3. in organic substances.

1. *In Substance.*

Properties.—Strychnia is found in commerce either as a white powder, or as a colourless crystal. In commercial specimens the form of the crystal is a rectangular prism, either of the exact shape shown in fig. 58, or with the ends replaced by one or two oblique planes. The crystals of strychnia, when

Fig. 58.



obtained from solutions of its salts by the addition of liquor ammoniæ, or, still better, by exposure to its vapour, present under the lens or microscope three leading forms—the long rectangular prism, the short hexagonal prism, or the regular octahedron. From a group of crystals obtained by exposing a drop of a solution of the acetate of strychnia to the vapour of ammonia, the forms shown in figs. 59 and 60 have been selected.* The crystals in fig. 59 are long four-sided

Fig. 59.

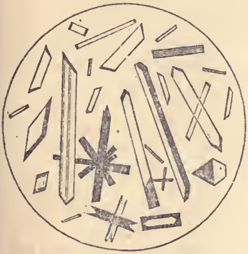


Fig. 60.

prisms, isolated or in stellate groups, with a single octahedron shown in contact with one of the prisms. The crystals in fig. 60 are either regular octahedra or modifications of the same, or short six-sided prisms. One or two of the crystals appear to be dodecahedra. The octahedra will be recognized in the several points of view in which they present themselves, on referring to the account given of the crystals of arsenious acid at p. 372.

Strychnia has an intensely bitter and very persistent taste, which is stated to be distinctly perceptible in solutions containing one grain of

* Acetate of morphia similarly treate yields prismatic forms only.

the alkaloid in a gallon (70,000) grains of water. Strychnia is very insoluble in water. It requires for its solution nearly 7000 times its weight of water at 50° (which is in the proportion of one grain in about fourteen measured ounces) and 2500 times its weight at 212°. But it is very soluble in alcohol, æther, benzole, and chloroform, and in some liquids in less common use. It is stated to be soluble in 350 parts of æther, 250 of benzole, 100 of alcohol, and 10 of chloroform. If pure it undergoes no change of colour when treated with the strong mineral acids; but as it usually contains some brucia, it is reddened by nitric acid.

Tests.—*a.* The form of the crystals as above described. *b.* The intensely bitter taste. *c.* The sparing solubility. *d.* The chemical colour tests, being the succession of rich hues imparted to a mixture of strychnia and strong sulphuric acid by contact with bichromate of potash and ferridcyanide of potassium and their solutions, or with the peroxide of lead and peroxide of manganese. *e.* The galvanic colour test, being the same colours developed by the electric current. The chemical and galvanic colour tests will now be separately described.

The Colour Tests.—1. Chemical colour tests. *a.* Place the smallest visible crystal or granule of strychnia on a surface of white porcelain, or on the glazed side of a piece of white enamelled glass. Add a drop of strong sulphuric acid, and mix the acid and alkaloid thoroughly with a small glass rod or spatula.* Near this acid mixture, which is colourless, place a drop of a strong solution of bichromate of potash. Bring the two liquids together with the point of the rod or spatula, having previously placed the porcelain or glass in a favourable light. At the point of contact of the two liquids a deep rich blue colour will make its appearance, and extend wherever the two liquids mix. This colour soon changes to purple, from purple to crimson, and from crimson to a rich red brown. It then gradually fades into a bright red, which colour it retains for several hours. *b.* Proceed in the same manner with a weak solution of the ferridcyanide of potassium, which yields similar and highly characteristic results. *c.* Place a drop of strong sulphuric acid on a surface of porcelain or enamelled glass. Add a minute fragment of the peroxide of manganese (not more than will impart to the acid when mixed with it a neutral tint). Draw out a thin line of this acid liquid with the point of the rod or spatula, and bring it into contact with a minute fragment or crystal of strychnia. Similar colours will develop themselves wherever the alkaloid is brought into contact with the mixture. *d.* Proceed in the same way with the peroxide of lead, substituting for strong sulphuric acid a mixture of one part of nitric to three of sulphuric acid. The same colours will be developed.

Of these tests, the first and last are to be preferred, though they all

* The glass spatula consists of a long triangle or spear-head of thin glass, fixed by its short side in a wooden handle. It will be found very convenient for this and all similar purposes.

give highly satisfactory results. It should be understood that they are equally applicable to spots of strychnia obtained by evaporating solutions of the alkaloid; as also to its salts.

2. *Galvanic Colour Test.*—This, like the foregoing tests, is applicable either to a crystal or granule of strychnia, or to a deposit of the alkaloid from any of its solutions. It is thus described by Dr. Letheby: "Place a drop of a solution of strychnia (say of one part of the alkaloid in 10,000, or even 20,000 of water) into a cup-shaped depression made in a piece of platinum foil. Allow the liquid to evaporate, and, when dry, moisten the spot with a drop of concentrated sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's or Smee's battery, and then touch the acid with the platinum terminal of the negative pole. In an instant the violet colour will flash out, and on removing the pole from the acid the tint will remain."

2. *In Solution.*

Strychnia differs from other poisons in the circumstance that the process now employed for extracting it from organic mixtures presents the poison not as an aqueous solution, but dissolved in one of the four liquids already specified, namely, alcohol, æther, benzole, and chloroform. The solution of strychnia in these reagents is allowed to evaporate in a watch-glass or on a disc of glass; and if the liquid hold sufficient of the poison in solution, a number of deposits are obtained, which should first be examined by the microscope, and then submitted to the action of the various tests. One or more of the stains should be treated with dilute acetic acid, so as to convert the strychnia into the acetate. To this acetate of strychnia, more or less diluted, the several tests to be presently described are to be applied. Assuming this method of procedure to be adopted, the form of the deposits from the solutions of strychnia in the four liquids, alcohol, æther, benzole, and chloroform will be described, and then the effect of certain chemical tests on the solution indicated.

Strychnia in alcohol, æther, benzole, and chloroform. *a. In alcohol.* The deposit from this solution is usually dendritic, but it may assume the shape of octahedra, long four-sided prisms and short six-sided prisms, with two long and four short sides. These forms are all depicted by Dr. Letheby ('Lancet,' June 28, 1856). *b. In æther.* This crystalline deposit usually assumes similar forms. *c. In benzole.* The solution of strychnia in benzole sometimes leaves on evaporation crystals of great brilliancy, distinctness, and permanence, in the form of octahedra, and of short six-sided prisms, the latter crystal constituting the prevailing form. Cubes and dodecahedra are occasionally met with. Generally, however, the deposit, though crystalline, does not put on the form of distinct crystals, even when the strychnia and benzole are apparently of great purity. *d. In chloroform.* The alkaloid is deposited from this solution in the forms of rosettes, veined

leaves, stellate dotted needles, circles with broken radii, and branched and reticulated forms of great delicacy and beauty. Some of these forms are shown in the annexed figure. My observation of these forms coincides with Dr. Letheby's as given in the paper just referred to.

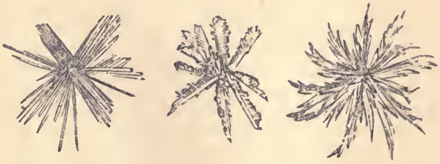
Fig. 61.

Other Chemical Tests. — A considerable number of chemical reagents have been recommended as tests for strychnia, among which the most important are:—the solutions of iodine and iodide of potassium; of the tannic and carbazotic acids; of the chlorides of mercury (corrosive sublimate), platinum, gold, and iron; of the bichromate and perchlorate of potash; and of the sulpho-cyanide of potassium. Some of these tests give amorphous precipitates, but the greater number throw down crystals, some of which are highly characteristic, and sufficiently constant to be considered as subsidiary tests.

It may be well to premise that the acetate of strychnia itself, to a weak solution of which the tests are supposed to be applied, crystallizes in tufts of needles, as shown in 1, fig. 62, and that when exposed to the vapours of ammonia, it yields the crystals shown in figs. 59 and 60.

Fig. 62.

1. 2. 3.



a. Iodine and Iodide of Potassium (a solution of these reagents in the proportion of one grain of iodine and three grains of iodide of potassium in a drachm of distilled water) constitutes a valuable test for the alkaloids as a class, and for strychnia in particular. It produces in solutions containing strychnia an abundant yellowish or reddish-brown precipitate, partly amorphous, partly crystalline. *b. Tannic acid.* A solution of this acid yields an abundant white curdy precipitate with the salts of strychnia, but it reacts similarly with other alkaloids. *c. Carbazotic acid* in solution yields with strychnia a white precipitate, and stellate and radiating crystals, with notched and

hooked edges, as in 2. fig. 62. *d.* A solution of *corrosive sublimate* causes an abundant white precipitate, which assumes the highly characteristic crystalline form depicted in 3, fig. 62. This is one of the best tests for strychnia. *e.* The *bichloride of platinum* yields a bright yellow precipitate. *f.* The *terchloride of gold* gives an abundant bright yellow precipitate which is dissolved by a few drops of liquor potassæ. On boiling this solution, it assumes a deep purple tint, and rapidly deposits a precipitate of the same colour. *g.* The *perchloride or permuriate of iron* causes an abundant yellow precipitate, and yellow octahedral crystals of great size and beauty. *h.* The *bichromate of potash* yields a bulky canary-yellow precipitate, consisting of abundant dendritic yellow crystals, with isolated colourless octahedra. *i.* The *perchlorate of potash* rapidly precipitates strychnia in long four-sided prisms, blended with other crystalline forms. *k.* The *sulphocyanide of potassium* yields an abundant white precipitate.

In making use of the foregoing tests it is necessary to bear in mind that some of them (as tests *a* and *b*) give similar reactions with other alkaloids; and that the crystalline forms described or depicted are not uniform in their occurrence. Differences in temperature, in the strength of the solution of strychnia, and in the strength and purity of the reagents, give rise to modifications in the forms of the crystals. Some of the reagents also (such as the bichloride of platinum) yield similar crystals of great distinctness and beauty. Hence, in all cases in which crystalline forms are examined under the microscope, a comparison should be made between the crystals resulting from the two liquids and those afforded by the reagent itself.* The crystals depicted in fig. 62 are not obtained from any other alkaloid in the group of alkaloids to which strychnia belongs; namely, that which is marked by the common property of not being changed in colour by strong sulphuric acid.

The Physiological Test.—This title has been given to a test first proposed by the late Dr. Marshall Hall, who alleged that the common frog, properly prepared for experiment, was not less susceptible of the peculiar effects of strychnia than of the convulsive effects of galvanism. He directed that frogs recently taken from the pond should be selected; that the skin should be well dried with blotting paper, and that the liquid to be tested, being a strong solution of a salt of strychnia, should

* Refer to papers by Dr. Letheby in 'Lancet,' June 28 and July 12, 1856. Also to two papers by Dr. Wormley in the 'Chemical Gazette,' April, 1860. Dr. Letheby's papers present the microscopic forms of strychnia as obtained by means of several reagents, while those by Dr. Wormley give the results of carefully conducted experiments on the chemical reactions of strychnia; from which it appears that the more important tests described above take rank in point of delicacy as follows:—The iodine test reacts with $\frac{1}{100000}$ grains of strychnia in a minim of water; tannic acid with $\frac{1}{30000}$; bichloride of gold $\frac{1}{30000}$; carbazotic acid $\frac{1}{20000}$; bichromate of potash $\frac{1}{15000}$; bichloride of platinum $\frac{1}{10000}$.

be dropped on the back of the animal. In a short time the frog thus treated became affected with tetanoid, or epileptoid spasm, or convulsion, on the application of the slightest cause of excitation. This test, according to Dr. Marshall Hall, detects so small a quantity as the $\frac{1}{5000}$th grain of the poison; and he thought that if inserted under the skin, or injected into the stomach, a still less quantity might be detected. The delicacy and certainty of this test have been fully confirmed by Dr. John Traill ('Lancet,' July 12th, 1856), by Dr. Harley, by Dr. Wormley, and others. Dr. Wormley ('Chemical News,' April 28th, 1860) gives an account of some experiments on a small species of frog (the Rana halecina), from which it appears that when a solution of strychnia was introduced into the stomach, quantities of strychnia much less than $\frac{1}{5000}$th grain produced characteristic effects.

The experiment is best performed as follows: Introduce the frog into a Powell's flat specimen glass, with the belly of the frog towards the flat surface; close the opening with a cork perforated to allow the passage of a pipette and glass rod. The skin of the frog should be dried before it is introduced into the vessel. Apply a drop or two of a solution of one of the salts of strychnia, or a solution in alcohol of the alkaloid itself, by the point of the pipette to the skin of the back. In a period of time varying from one or two minutes to a quarter of an hour or more, the characteristic tetanic convulsions will show themselves, and will recur every time the glass is shaken, or the frog touched with the glass rod. In many cases the frog utters a shriek or cry expressive of pain. When the dose is large, the symptoms show themselves almost immediately, and death takes place in a few minutes. When the dose is smaller, the symptoms come on after an interval of a quarter of an hour or half an hour, and the animal may recover. The characteristic symptom is generally ushered in by a state of evident distress, with panting respiration and protruding eye.

3. *In Organic Substances.*

The process which seems best adapted to the detection of strychnia in the contents of the stomach, or in the animal fluids and tissues, is the one originally recommended by Stas, but since modified by the substitution of chloroform or benzole for æther.* The organic matters are first digested with from ten grains to half a drachm of tartaric acid, over a water-bath, till they are reduced to a fluid state. This liquid is then filtered, and the substance remaining on the filter washed with distilled water so long as it has an acid reaction, the washings being added to the filtrate. The liquid is then to be somewhat concentrated by evaporation, and carbonate of soda is to be added in slight

* Messrs. Rodgers and Girdwood ('Medical Times and Gazette,' June 20th, 1857) treat the organic mixture with dilute hydrochloric acid (one part acid and ten water), and ultimately resort to chloroform as a solvent of the alkaloid.

excess. The liquid is now to be strongly shaken for several minutes in a bottle or long tube with about half an ounce of chloroform (Messrs. Rodgers and Girdwood), or with benzole (Professor Bloxam). The chloroform, having been allowed to subside, or the benzole to collect on the surface, is drawn off by a pipette, transferred to an evaporating basin, and expelled over a water-bath. If the residue left in the basin is free from colour, it may be at once tested for strychnia; but if not, it must be moistened with concentrated sulphuric acid, and exposed for some hours to the temperature of a water-bath, by which procedure all the organic matters except the strychnia is destroyed. The charred mass is then treated with water, and the solution filtered to separate the carbon. Ammonia is added to excess, and the solution again shaken with about a drachm of chloroform. If, on evaporating a small portion of this chloroform solution, and acting on the residue with strong sulphuric acid, any charring takes place, the same process must be repeated. The chloroform solution ultimately obtained affords strychnia sufficiently pure for the application of the several tests. The colour tests may be applied to the deposit left on a porcelain slab after repeated evaporations; the deposit on a slip of glass may be examined under the microscope; and a solution of the deposited matters in dilute acetic acid may be examined by the several tests just described.

By this process very satisfactory results are obtained.* Strychnia has now been detected in the contents of the alimentary canal, in the muscles and viscera, and in the blood and urine. Messrs. Rodgers and Girdwood also state that they detected it in the bones. There is no longer any room for doubt that strychnia, like arsenic, antimony, and mercury, undergoes no change in the alimentary canal, in the vessels of the body, or in the secreting organs; but that it can be detected in organic fluids and tissues by a proper method of analysis carefully and skilfully conducted.

In a medico-legal case lately examined by Professor Bloxam, he substituted benzole for chloroform, and obtained beautiful crystalline forms similar to those just mentioned as characterizing the deposit from a solution of strychnia in benzole. Benzole, though a less perfect solvent than chloroform, has the twofold advantage of being lighter than water, and leaving a crystalline deposit of a more marked character.

Experiments on Animals.

The effect of strychnia on animals varies with the dose of the poison, and the state in which it is administered. A large dose of a salt of strychnia given in solution may begin to act almost immediately, and prove fatal in a minute and a half. A smaller

* See the particulars of a recent analysis by Dr. Letheby, in a case of poisoning by strychnia, in the 'Chemical News,' September 29, 1860, and 'Br. Med. Journal,' August 4, 1860, in which a similar process was adopted.

dose may not produce any effect for several minutes, and death may not ensue for twenty minutes or half an hour; or severe symptoms may be developed, and yet the animal recover. The symptoms produced by the poison in animals are well shown in the following instance. Dr. Taylor gave to a full-grown healthy rabbit, which had been recently fed, a quarter of a grain of sulphate of strychnia dissolved in a few drops of distilled water. The animal remained active for fifteen minutes, but at that time appeared easily startled, tremulous in its movements, and unsteady on its legs. Soon afterwards it trembled violently, or started when touched; and slight twitchings occurred in the limbs at intervals on its attempting to move, or on making a noise. After the lapse of eighteen minutes no well-marked convulsion of the trunk had occurred; but when gently lifted by the ears from the table to the floor, it was seized with a violent convulsive paroxysm. The hind and fore legs were rigidly stretched out, and there was complete opisthotonos. Its eyes protruded; its breathing was difficult; the pulsations of the heart could not be counted; the head and tail were drawn backwards, as if by a tightened bow-string, with occasional slight intervals of relaxation; and in this state it died, two minutes after the commencement of the convulsions, and twenty minutes after taking the poison. Immediately after death the whole body was flaccid; but it speedily stiffened, and the fore limbs altered their position, and became rigidly stretched out. In eight minutes from the death, while the body was still warm, the muscles were rigid over the greater part of the trunk. On inspecting the body, the lungs were found collapsed, and of a bright red colour; the heart contained blood, chiefly coagulated, on both sides; the blood in all other parts of the body was liquid, and dark coloured.*

The mode and immediate cause of death in animals poisoned by strychnia are not uniform. From the experimental inquiries instituted by Dr. Harley, of University College, London, and Mr. Bayldon, of Edinburgh, it may be inferred that death may take place by shock, by apnœa, by syncope, or by exhaustion; and that the poison affects not the nervous centres only, but the muscular tissue of the heart, and of the voluntary muscles.

SYMPTOMS, POST-MORTEM APPEARANCES, AND TREATMENT.

Symptoms.—At an interval of from a few minutes to an hour or more after swallowing a substance which, if in solution, would have a hot and intensely bitter taste, the symptoms of poisoning set in with a feeling of suffocation and difficulty of breathing, the patient complaining of want of air. These feelings of distress are soon followed by twitchings of the muscles, and jerking movements of the head and

* For a minute account of several experiments on animals, and a collection of several cases in the human subject, with an examination of the case of Palmer, see Dr. Taylor's Essay, reprinted from the 'Guy's Hospital Reports.'

limbs, which shortly become heightened into tetanic convulsions. The limbs are forcibly extended, the legs widely separated, and the feet often turned either inwards or outwards, the head bent back, and the whole body arched so as to rest on the head and heels. This position is technically designated '*opisthotonos*.' The muscles of the abdomen are rigidly contracted, respiration suspended, the face livid and congested, the pupil (in the fit) usually dilated, the eyes prominent and staring, and the features drawn into a grin (the risus sardonicus). The patient complains of a choking sensation, and of thirst and dryness of the throat; but the effort to drink often occasions rigid and violent spasms of the muscles of the jaw. There is sometimes foaming at the mouth, and the froth is occasionally tinged with blood. The violent contractions of the muscles are accompanied by pain at the pit of the stomach and cramps in the limbs, and by intense suffering and distress. The pulse is very rapid. After the spasms have lasted for one or two minutes there is a remission of short duration, and the patient remains exhausted, and bathed in sweat. The fits sometimes return without apparent cause, but they may be brought on by the slightest touch, or the least effort of the patient. In the intervals of the fits the patient can converse, and swallow, and the jaw is not always fixed even in the fit. The mind is generally unaffected till towards the fatal termination, and may even continue clear to the last. The patient is generally quite conscious of his danger, and aware of the approach of his paroxysms, which he announces by screams or shrieks, or by calling out that "they are coming;" and he often asks to be held, moved, or turned over. Towards the fatal termination, the fits become more frequent and severe, and the patient dies exhausted, or suffocated, in most cases within two hours of the commencement of his symptoms. If a patient survive that period there would be fair hope, but not a certainty, of recovery.

The *post-mortem appearances* in death by strychnia are not highly characteristic, nor are they uniform. As a general rule, the body would seem to be relaxed at the time of death; but it stiffens soon afterwards, and remains rigid for a long time. The hands are usually clenched, and the feet arched, or turned inwards. In some cases the body retains the posture given to it by the last fatal spasm. There is usually some lividity about the face, trunk, and limbs. The expression of the countenance is sometimes quite natural. The internal appearances consist in congestion of the brain and spinal cord, of the lungs and air-passages, and sometimes of the mucous membrane of the stomach. The heart is sometimes contracted, and all its cavities empty; in other cases the right side is full of blood. The blood throughout the body is black and fluid. The urinary bladder is empty.

The *treatment* consists in the prompt evacuation of the stomach by emetics or the stomach-pump, and then in the administration of chloroform, for the relief of the pain attending the spasms. There is no antidote to the poison unless finely-divided charcoal is to be con-

sidered in that light. Opium, tobacco, and the active principles of tobacco and conium, have been recommended as tending to relieve the patient's sufferings, or relax the muscular contractions.

Commencement of Symptoms.—The symptoms may show themselves in from five minutes to an hour or more.

Fatal Period.—Death may take place in fifteen minutes, or not till the lapse of two hours and three quarters. These were the limits in eleven cases which I have minutely analyzed.

Fatal Dose.—A quarter of a grain of strychnia may destroy life; but recovery may take place after much more considerable doses.

From the account just given of the symptoms of poisoning by strychnia, it will be seen that they are closely allied to those of the disease known as tetanus or locked jaw. In poisoning by strychnia, as in tetanus, there are violent paroxysms of rigid convulsion, with intense suffering; and in both the mind is little if at all affected; and when it does suffer, it is apparently as the result of the exquisite tortures which the patient has undergone.

The differences between the disease, tetanus, and the effect of poisoning by strychnia are well marked. In this country, and in temperate climates, tetanus is rare, except as the consequence of a wound or severe mechanical injury. In tetanus the symptoms are at first obscure, and develop themselves gradually: in poisoning by strychnia they are strongly marked at the onset, and attain their full development in a few minutes. Tetanus begins with difficulty of swallowing and stiffness of the jaws and neck, the trunk, legs, and arms being attacked in succession. In poisoning by strychnia, all, or nearly all, the voluntary muscles are attacked at the same time; and the muscles of the jaw are not only not affected first, but sometimes wholly escape, or are violently contracted only during efforts to swallow. In tetanus, opisthotonos does not occur till after some hours or days: in poisoning by strychnia, it is among the early symptoms. In tetanus, the symptoms undergo abatement, but there is no perfect intermission: in poisoning by strychnia there are intervals of complete intermission. In tetanus the patient either dies after the lapse of several hours or days, or recovers slowly after several days or weeks: in poisoning by strychnia death happens in from less than a quarter of an hour to less than three hours after the first appearance of the symptoms, or the patient recovers in a few hours.

The tetanus occasioned by strychnia is distinguished from that which occurs in the course of poisoning by several of the more active irritants and narcotico-irritants, inasmuch as the tetanus of strychnia-poisoning constitutes the one symptom, whereas the tetanus of irritant and narcotico-irritant poisoning occurs after other symptoms of poisoning have shown themselves, or is mixed up with them. To this rule, however, it is possible that the salts of morphia, in certain cases, may form an exception. (See p. 448)

The tetanic convulsions of hysteric and epileptic seizures are

similarly distinguished from the tetanus of strychnia-poisoning, by forming only a part of the fit. These seizures, moreover, are not in themselves fatal. Death from hysteria is unknown, and it very rarely follows immediately or speedily on an epileptic seizure. There is a marked difference, also, in the character of the convulsive movements in the diseases just specified, and in poisoning by strychnia. Strychnia produces a violent rigid tremor, uniformly continuous throughout the paroxysm; whereas epileptic, epileptiform, or hysteric convulsions are marked by a more or less regular alternation of relaxation and contraction of the muscles. In a word, the tetanic paroxysm is distinguished by uniform *rigid tremor*, the epileptic or hysteric fit by *jactitation.*

Brucia.

This alkaloid derives its importance from its being associated with strychnia in the seed and bark of nux vomica, and in St. Ignatius' bean. It possesses the same poisonous properties as strychnia, but in a less degree of intensity, variously estimated at a sixth or a twelfth.

Properties.—Brucia is usually found in the form of a white powder, consisting, in part, of crystals. It is more soluble in water than strychnia, insoluble in æther, but very soluble in alcohol. Its aqueous solution has an intensely bitter taste. With acids it forms salts. Strong and pure sulphuric acid does not discolour it; but it is described as giving it at first contact a pale rose tint.

Tests.—a. In common with many other alkaloids, brucia is precipitated of a red-brown colour by the solution of iodine in iodide of potassium. *b.* It is also precipitated white by tannic acid. *c.* Nitric acid imparts to brucia and its salts a deep rich red colour. This red solution, if warmed and then allowed to cool, is changed to a purple hue by protochloride of tin, and bleached by an excess of the solution. *d.* Strong sulphuric acid, followed by bichromate of potash, ferridcyanide of potassium, and peroxide of lead, or peroxide of manganese, develops immediately a red or reddish-brown colour, passing to green and yellow. *e.* The ferridcyanide and sulphocyanide of potassium, the bichromate of potash, carbazotic acid, the bichloride of platinum, and the terchloride of gold, also yield precipitates. (Consult a paper by Dr. Wormley in the 'Chemical News,' July 21, 1860.)

It will be seen from what has just been stated that brucia belongs to the same group of alkaloids as strychnia, namely, to the group which is characterized by the absence of colour when treated with strong sulphuric acid. But it differs from strychnia in giving a more intense red with nitric acid, and in the absence of the rich deep blue tint developed by the contact of bichromate of potash in substance or solution, with the solution of the alkaloid in sulphuric acid. The crystalline forms yielded by strychnia with the several reagents are also more distinct and characteristic than those afforded by brucia.

CHAPTER XIX.

1. Belladonna.
2. Hyoscyamus.
3. Stramonium.
4. Camphor.
5. Œnanthe crocata.
6. Cocculus indicus.
7. Lolium temulentum.
8. Poisonous mushrooms.

The poisons belonging to this group are characterized by the common leading property of causing delirium, with illusions of the senses. Other poisons of the narcotico-acrid class either do not give rise to delirium, or they produce it only exceptionally. They also share, with other poisons of the narcotico-acrid class, the property of causing dilatation of the pupil, but more constantly and in a more remarkable degree. Irritation of the stomach and bowels is present in a sufficient number of cases to justify their being classed with the narcotico-acrid poisons. Dysuria, or suppression of urine, is also not uncommon. The poisons at the head of the group are the most conspicuous of their class; the others, as being less important, are more briefly noticed. For more ample details respecting them, reference must be made to treatises on toxicology.

1. Belladonna (*Atropa Belladonna. Deadly Nightshade*).

This is a plant of the Linnæan class and order, *Pentandria Monogynia*, and natural order, *Solanaceæ*.

It is indigenous, and grows in waste shady spots. All parts of the plant are poisonous, and cases of poisoning by the *root*, *leaves*, and *berries*, and by the medicinal *extract*, are on record, several of which proved fatal. A decoction of the root, given as a clyster, has also caused death, and serious symptoms have followed the external application of the extract to a blistered surface.

The plant owes its poisonous properties mainly to the alkaloid *atropia*, which has been admitted into the Pharmacopœia, with one of its salts, the sulphate.

The officinal preparations of the plant itself are, the *extract*, chiefly used externally, but occasionally internally, in doses of gr. ½ to gr. i, cautiously increased; the *tincture* (dose from five to ten drops); and for external application, the emplastrum and unguentum belladonnæ.

The parts of the plant which have been taken as poisons are readily recognized. The *root* is thick and fleshy, branched and creeping; its section, white when fresh, and greyish when dried. It has a slightly bitter taste. The *leaves*, often in pairs of unequal size, ovate and undivided, smooth and soft, are attached to the stem by short foot-stalks. The *berries* of the size of a small cherry, furrowed on each side, of a shining violet black colour, and of a sweetish taste, are enclosed in the enlarged calices. They have two cells, which contain several seeds. The seeds are of the small size shown in fig. 63, with circular or oval outline, and rounded surfaces; sometimes they are kidney-shaped. Their colour is nut-brown. They weigh about ninety to the grain. When viewed by a pocket lens, they look like sultana raisins in miniature, and are studded closely with equal small round projections. Viewed by reflected light, under a two-inch power of the microscope, they have the appearance shown in fig. 63.

Fig. 63.

As all parts of the berries, and the seeds which they contain, are very indigestible, portions of them will be found, in cases of poisoning, in the matters rejected by the stomach, or passed from the bowels.

The entire plant has a lurid hue, and when bruised, a fetid odour.

The *extract* of belladonna has the property which, however, it shares with that of hyoscyamus and stramonium, of causing dilatation of the pupil when locally applied, or when taken internally.

The effects of belladonna on animals are not very characteristic. In them, as in man, it dilates the pupils, and it produces a state allied to intoxication.

In the human subject, the symptoms of poisoning by belladonna are the following: dryness of the throat, great difficulty of swallowing, or even total inability to swallow, and intense thirst, followed by delirium, ending in coma, or alternating with it. Convulsions are rare, and when present, generally slight. The pupil is largely dilated, the countenance flushed and swollen, the eyes prominent and sparkling, the vision indistinct, the gait unsteady. Symptoms of irritation in the alimentary canal, beyond dryness and constriction of the throat, are of very rare occurrence; but nausea and unsuccessful efforts to vomit are recorded in some cases, and aphthous inflammation of the throat, swelling of the abdomen, and discharge of blood by stool, in at least one instance. Violent strangury, suppression of urine, and hæmaturia, have also been reported, as also an eruption on the skin, said to resemble that of scarlatina. The symptoms rarely show themselves till two or three hours, or even more, after the swallowing of the poison; but in some instances they have set in within half an hour. The fatal cases bear but a small proportion to the cases of recovery. Death, when it occurs, takes place within twenty-four hours; in one case in fifteen hours; in another in twelve hours. Favourable cases often last

for two or three days or more; and some of the leading symptoms, such as impaired vision, and greatly dilated pupil, survive the recovery of the patient.

The *delirium* is generally a very prominent symptom. It is sometimes pleasing, sometimes accompanied by uncontrollable laughter, sometimes by incessant talking, sometimes only by motions of the lips, the voice being lost. Sometimes the state of the patient closely resembles somnambulism, at others intoxication. The patient is generally unconscious, and, on recovery, does not recollect what has happened to him. Generally, the delirium precedes the sopor or coma; but sometimes the order is reversed, and sometimes the two states alternate. *Trismus* and *subsultus tendinum* are recorded among the nervous symptoms of occasional occurrence.

The *vision* is affected synchronously with the extreme dilatation of the pupil. Sometimes there is merely indistinctness of vision, sometimes double vision, sometimes utter insensibility of the retina.

The *post-mortem appearances* are sometimes quite unimportant; in other instances they have been described as those of narcotico-irritant poisoning. The vessels of the brain are congested, and there are patches of redness in the pharynx and œsophagus, and at the cardiac end of the stomach. The mucous membrane of the stomach has been found dyed of a dark purple colour throughout, or in patches, and portions of the berries and some of the seeds have been detected in the intestinal canal.

The *treatment* consists in the prompt administration of emetics, followed by animal charcoal diffused through water, and this, after an interval, by a full dose of castor oil. In other respects it will be determined by the symptoms actually present. Bleeding may be practised with advantage.

The *diagnosis* of the poisoning is not free from difficulty. The symptoms are very similar to those present in poisoning by hyoscyamus and stramonium. It is only the discovery of some portion of the plant itself in the substances rejected from the stomach, or passed from the bowels; or, in a fatal event, in the contents of the alimentary canal, which will enable us to state with confidence what poison has been taken. In many instances the description given of the part of the plant swallowed is quite decisive. The berry is easy to recognize.

ATROPIA (*Atropine*).—This alkaloid, with one of its salts (the sulphate), is admitted into the London Pharmacopœia, and used medicinally.

Properties.—When pure, it is in the form of white silky crystals, which when viewed under the microscope are four-sided prisms. It is sparingly soluble in water, but soluble in alcohol and æther. It is also soluble in the dilute acids, with which it forms crystallizable salts. The solution of iodine in iodide of potassium, and tannic acid, throw down respectively a greenish-brown and dirty white precipitate.

Tests.—It is dissolved by sulphuric acid, and the solution is changed to a rich brown when heated. This solution also bleaches a solution of the permanganate of potash; and with a solution of the bichromate

of potash yields a rich red colour, changing to red-brown and yellow. Nitric acid dissolves it without change of colour. The bichloride of platinum and the terchloride of gold yield yellow precipitates. The solution of the alkaloid, and of its salts, has the property, which, however, it shares with hyoscyamia and daturia, of causing dilatation of the pupil.

The alkaloid may be detected in organic mixtures, when it is in sufficient quantity, by the method of Stas—a method which, as it is applicable to the isolation and identification of the alkaloids as a class, may be here conveniently described. This method is founded on the ascertained fact that the salts of the alkaloids are soluble in water and in alcohol; and that their aqueous and alcoholic solutions, when neutralized by an alkali, so as to set free the base, and then shaken with æther, yield the base to the æther. The following are the several leading steps of this process.

The organic matters cut into small fragments are first mixed with double their weight of strong pure alcohol; from 8 to 30 grains of tartaric or oxalic acid are added, and the mixture heated over a water-bath. When cold the liquid is filtered, and the matters on the filter are washed with strong alcohol, and the washings added to the filtrate, which is then evaporated in vacuo over sulphuric acid. The residue is now treated with cold anhydrous alcohol, the alcoholic extract evaporated to dryness, and this residue in its turn dissolved in a very small quantity of distilled water. This aqueous solution is mixed with powdered bicarbonate of soda or potash till effervescence ceases, and then shaken up with from four to six times its volume of pure rectified æther. When the æther has collected on the surface, it is withdrawn by the pipette, and evaporated in a watch-glass. The deposit contains the alkaloid. Some parts of this process are repeated in order to insure greater purity in the ultimate result. (For a more detailed account of this process, and the modifications required in the case of the volatile alkaloids, see Otto's 'Manual of the Detection of Poisons,' p. 156.)

2. Hyoscyamus (*Hyoscyamus Niger. Henbane*).

This, too, is a plant of the Linnæan class and order *Pentandria Monogynia*, and of the natural order *Solanaceæ*. It is indigenous, and grows on waste and poor lands, and on the sea-shore. All parts of the plant are poisonous, and the seeds, root, leaves, and young shoots have severally been taken as poisons.

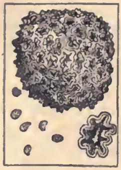
The plant owes its poisonous property to an alkaloid known as *hyoscyamia*, and a peculiar volatile principle.

The London Pharmacopœia contains two preparations of henbane—the *extract*, procured from the fresh leaves, and the *tincture*, from the dried leaves. The dose of the extract is from 5 grains to a scruple, and of the tincture from 20 drops to a drachm, a drachm and a half, or two drachms. These preparations are of very variable strength.

The several parts of the plant which have been taken as poisons are easily recognized.

The *seeds* are of about the same size and shape as those of belladonna, but less rounded. They are about an eighteenth of an inch in diameter, and weigh 120 to the grain. Under the pocket lens they appear dotted over their entire surface by slight projections; and under the lower powers of the microscope they look very much like pine-apples in miniature, being thickly covered with ridges formed of nipple-like projections separated by distinct furrows, the projections being marked with black lines, as shown in fig. 64, which represents the seeds of their usual size, and as seen by reflected light under a two-inch power of the microscope.

Fig. 64.



The *root* is spindle-shaped, and bears some resemblance to a small parsnep, for which it has been eaten by mistake. It also somewhat resembles the wild chicory.

The *leaves* are of a pale dull green colour, slightly pubescent, with long hairs upon the midrib, unequally cut at the sides and pointed at the end. They are sessile, and half embrace the stem of the plant. They have, in common with the rest of the plant, a strong and unpleasant odour, a mucilaginous and slightly acrid taste, and a clammy feel.

The different parts of the plant, and its officinal preparations, vary greatly in activity and strength, according to the season of the year and the mode of preparation.

Effects of the Poison on Animals.—Purely narcotic; no local symptoms. Dilatation of the pupils a very marked symptom.

Symptoms in Man.—The symptoms make their appearance in from a few minutes to half an hour. When fully developed, they consist of flushing of the face, giddiness, rapid pulse, weakness, and trembling of the limbs, convulsive or tetanic movements, delirium (commonly of the active or violent kind), incoherence, the delirium terminating in coma, or alternating with it, loss of speech, great dilatation of the pupil, and indistinctness of vision, or total loss of sight.

Heat and dryness of the throat, vomiting and diarrhœa, are present in a sufficient number of cases to justify us in placing henbane among the narcotico-acrid poisons; but those symptoms certainly occur in a minority of cases. A cutaneous rash has been observed.

Poisonous effects have been produced by a poultice of the leaves applied to the abdomen, and by a decoction of the plant used as a clyster.

The most *characteristic symptoms* are delirium, and *dilated pupil.* This dilatation of the pupil is caused by the application to the eye of the preparations of henbane.

The *post-mortem appearances* are congestion of the brain and lungs.

The *treatment* is that of poisoning by belladonna.

In consequence of this poison being generally taken by mistake for some wholesome vegetable (either leaves or root), and cooked as an article of diet, the symptoms have commonly been described as affecting several persons simultaneously.

HYOSCYAMIA (*Hyoscyamine*).—This rare alkaloid is sometimes seen in the form of white silky crystals, but generally as an amorphous mass. It is without odour when quite pure; but, as generally procured, has a very disagreeable odour, like that of tobacco, and an acrid taste. It is not very soluble in water, but more readily dissolved in alcohol and æther. It forms salts with acids. Strong nitric acid dissolves it without change of colour, and strong sulphuric acid colours it brown. It is one of the alkaloids which M. Stas succeeded in obtaining by his process, for a description of which see p. 505.

3. STRAMONIUM (*Datura Stramonium, Thorn-Apple*).

This also is a plant of the Linnæan class and order *Pentandria Monogynia*, and natural order *Solanaceæ;* growing in waste places and on dung-heaps in all parts of Europe. Every part of the plant is poisonous; but the fruit and seeds are believed to be the most active. The vapour of the flowers is asserted to have produced poisonous effects. In France and Germany, as also in India, and the Eastern Archipelago, the seeds are administered intentionally to facilitate the commission of crime. Cases of poisoning by the leaves, fruit, seeds, and extract are on record. Dangerous symptoms have been occasioned by the external application of the several parts of the plant.

The extract of stramonium is in the London Pharmacopœia, and is given in doses of $\frac{1}{4}$ gr. to 2 or 3 grains, or it may be applied externally. It is smoked with tobacco as a remedy for asthma.

Stramonium owes its poisonous properties to an alkaloid, known as *daturia*.

The appearance of the plant and of its parts is highly characteristic. The entire plant has a rank odour. The flowers, however, are sweet-scented.

The *leaves* are of a dull green colour: they are large, sharply and irregularly cut at the edges, smooth, ribbed, and veined.

The *fruit*, or apple, is as large as a walnut, and has a strong prickly outer coat.

The *seeds* are light brown or black, circular or nearly so, sometimes kidney-shaped, flattened, with a corrugated surface. They are much larger than the seeds of henbane or belladonna, which they resemble in shape; for while the seeds of henbane measure about the eighteenth of an inch, and the seeds of belladonna about the sixteenth, the stramonium seed measures about the eighth of an inch, or from that to the tenth of an inch; and while the seeds of henbane weigh 120 to the grain, and those of belladonna 90 to the grain, there are only about 8

stramonium seeds in one grain. The size and the microscopic appearance of the cuticle of the seeds are shown in the annexed figure.

Fig. 65.

The *effects of this poison on animals* are not very characteristic. In common with henbane and deadly nightshade it causes extreme dilatation of the pupil.

The *symptoms* of poisoning by stramonium, in the *human subject*, nearly resemble those of poisoning by henbane and the deadly nightshade. There are dryness of the throat, flushing of the face, dilatation of the pupils, delirium, accompanied by convulsions and followed by coma, and, in some instances, symptoms of irritation in the alimentary canal.

The symptoms set in very soon after taking the poison, and seem to be more severe than those of poisoning either by henbane or deadly nightshade. Delirium may be present in as short a space of time as 15 minutes, and death may take place in 7 hours.

Post-mortem Appearances.—In some cases congestion of the vessels of the brain has existed, and in one instance redness of the cardiac end of the stomach.

The *treatment* of cases of poisoning by stramonium will consist in the prompt use of emetics, followed by full doses of castor oil; and where there is much flushing of the face, the abstraction of blood from the arm, or by leeches to the temple. In one case reported in 'Rust's Magazine,' bleeding appears to have afforded great relief, and would seem to be applicable in poisoning by henbane and deadly nightshade, as well as the thorn apple, and in cases of poisoning generally where the face is flushed and the eyes prominent and brilliant.

Daturia.—This alkaloid is believed to differ very little in its composition and properties from atropia; like it, it is found in silky crystals, which are four-sided prisms. It produces the same effect on the pupil of the eye as the alkaloids atropia and hyoscyamia.

The *diagnosis* of poisoning by stramonium is only possible by the history of the case, or by the discovery of portions of the plant in the alimentary canal, or in the matters vomited or purged.

4. Camphor.

This substance has decidedly poisonous properties, but has only proved fatal in one instance.

Properties.—It is a colourless, translucent, and semi-crystalline

substance of a tough texture, strong and peculiar odour, and pungent and yet cool taste. It floats on water, in which it is sparingly soluble. It evaporates at common temperatures, and is deposited on cool surfaces (as on the inside of bottles) in crystals. It is readily dissolved by alcohol, æther, and chloroform, and by the volatile and fixed oils. When swallowed it imparts its peculiar odour to the breath.

When taken as a poison it is usually in fragments, and being sparingly soluble in the contents of the stomach, would be easily identified in a fatal case. If dissolved in spirits, it may be separated by distillation, and then thrown down by the addition of water.

The *symptoms* of poisoning by camphor begin with languor, giddiness, dimness of vision, and confusion of intellect, which are followed by feelings of depression, intoxication, or violent delirium. Convulsions also occur, especially in children; and there is much excitement of the circulation, with heat of skin, flushed face, and hurried pulse; and the pupils are dilated.

The *post-mortem appearances*, as observed in animals, are distinct marks of inflammation in the stomach and bowels, injection of the membranes of the brain, and an inflammatory condition of the urinary passages. Every part of the bodies of the animals had the odour of the poison.

The *smallest fatal dose* has not been ascertained. Two scruples have produced serious symptoms in an adult male.

The *treatment* consists in the prompt use of emetics, followed by castor oil as a purgative. The discharge of the contents of the stomach is generally followed by speedy relief.

5. Œnanthe crocata (*Hemlock Water Dropwort*).

This is an indigenous umbelliferous plant, which grows on the banks of streams and ditches, and bears some resemblance to celery. All parts of the plant are poisonous; but the root, from a rough resemblance to the parsnep, is generally the part eaten by mistake. The plant is so virulent a poison that a very small piece of the root has proved rapidly fatal.

The *symptoms* may set in as soon as twenty minutes after swallowing the poison, with convulsions and insensibility. The face livid and bloated, the mouth and nostrils covered with bloody foam, and the respiration stertorous, and death may follow in as little as five minutes from the first seizure. In more protracted cases nervous symptoms of great severity show themselves, consisting of locked jaw, tetanic spasms, and violent mania, or delirium allied to delirium tremens. The pupil is usually dilated. There are also symptoms of violent irritation in the alimentary canal.

The *post-mortem appearances* consist of great congestion of the brain; an accumulation of dark blood in the lungs, heart, and large vessels; and signs of irritation in the stomach and bowels.

The *treatment* consists in the prompt discharge of the contents of the stomach by emetics, followed by a full dose of castor oil. Bleeding is indicated by the congested state of the cerebral vessels. The remainder of the treatment will be determined by the symptoms actually present.

6. Cocculus indicus (*Levant Nut*).

This is the berry of a plant known as the Menispermum, or Anamirta Cocculus. It is of the size and shape, and exhibits the section shown in fig. 66. The shell acts as an emetic, while the seed itself contains an active poison (Picrotoxia), in the proportion of from 1 to 2 per cent. An extract of the berries is sold for poisoning fish, to which, when used in large quantity, it imparts a poisonous property, and a decoction or extract is employed to give an intoxicating quality to ale, porter, and spirits. It is used, too, with this intent by thieves. In two instances, at least, the poison has proved fatal in the human subject.

Fig. 66.

The *symptoms* are those of severe irritation in the alimentary canal, and cerebral effects, including delirium, and "a lethargic stupor, with a consciousness of passing events, but a complete loss of voluntary power." (Taylor.)

Picrotoxia (*Picrotoxine*).—This poison is obtained in the form of colourless crystals, which are long four-sided prisms. Its taste is intensely bitter. The crystals are sparingly soluble in water, but are readily dissolved by alcohol and æther. It is also sparingly soluble in acids, but soluble in solutions of potash and soda. For this reason, and because it does not contain nitrogen, it is not properly grouped with the alkaloids. (Otto.) Sulphuric acid dissolves it without change of colour, but the acid solution becomes yellowish when it is warmed, and brown when it is heated. On the addition of a solution of bichromate of potash to the acid liquid, it assumes a rich yellow tint. Nitric acid dissolves it without change of colour. An alkaline solution, with addition of sulphate of copper, when heated deposits the oxide of copper.

7. Lolium temulentum (*Darnel*).

The seeds of this plant are sometimes mixed with other grains, used for distillation, or ground into flour for making bread. When so used they may produce marked symptoms of narcotico-acrid poisoning, including headache, giddiness, staggering as if from intoxication, strong tremulous movements of the limbs, impaired vision, symptoms of collapse, and vomiting.

8. Poisonous Mushrooms or Fungi.

The fungi constitute a large class of plants, of which some are habi-

tually eaten with impunity, except by a few persons of peculiar constitution; while the majority, especially those belonging to the three genera *Amanita*, *Agaricus*, and *Hypophyllum* are poisonous. The poisonous property is sometimes destroyed by heat; but in other cases, when it is due to an alkaloidal principle known as *fungia* or *fungine*, it is permanent.

The *symptoms* of poisoning by this class of substances are very variable in the time at which they appear, sometimes coming on soon after eating them, in other cases not till the lapse of perhaps twenty-four or even thirty-six hours. Cases also differ from each other in the order in which the symptoms are developed. Sometimes symptoms of irritation of the alimentary canal precede the nervous symptoms, but sometimes they follow them; and in the same group of cases, some patients will suffer from symptoms of irritation, others from nervous symptoms. The symptoms of irritation consist of vomiting, with or without purging; and the nervous symptoms of headache, giddiness, dimness or confusion of sight, intoxication, delirium, or coma.

The *post-mortem appearances* consist in marks of inflammation in the stomach and bowels, and of congestion in the brain.

The *treatment* consists in the prompt use of emetics, followed by a full dose of castor oil.

Precautions.—As a general rule, highly-coloured mushrooms and fungi, and those which grow in damp and shady spots, as well as those which have a disagreeable odour, and astringent taste, are to be rejected as articles of food. The orange-coloured *amanita muscaria*, which appears in the autumn, is one of the most poisonous species, and should especially be avoided.

CHAPTER XX.

1. Aconite.
2. Digitalis.
3. Tobacco.
4. Lobelia inflata.
5. Conium.

The poisons contained in this chapter are characterized by the effect they produce on the organs of circulation and respiration; their leading symptom being syncope or asphyxia, while the mental faculties are generally, but not universally, unaffected. The irritation of the alimentary canal which characterizes the whole class of narcotico-acrids is, as a general rule, more strongly marked in the case of these poisons than of those contained in the preceding chapter.

1. Aconite (*Aconitum Napellus, Monkshood, Wolfsbane, Blue-rocket*).

With the exception of the Aconitum ferox, which grows on the Himalayan mountains in India, the Aconitum napellus is the most active poisonous plant of the many which go by the name of *aconite.* Some of them have no poisonous property whatever. But not only is the Aconitum napellus, with this single exception, the most active poisonous plant bearing the name of aconite; it is also, when compared with other poisonous plants, a very fatal one; and there is reason to believe that *aconitina*, the active principle of the plant, is the most deadly poison in existence.

Monkshood is a beautiful plant, growing from two to six feet in height, with dark-green leaves, of very characteristic form, and a terminal spike of rich blue flowers. It grows on hilly ground in many parts of Europe, is supposed to be indigenous, and is often cultivated as a garden flower. It belongs to the Linnæan class and order, *Polyandria trigynia*, and the natural order *Ranunculaceæ*, or *crowfoots.*

All parts of the plant are poisonous, but the root is the most active. Both the *root* and the *leaves* have been several times taken as poisons; and the *extract* and *tincture* have also proved fatal.

The London Pharmacopœia contains two preparations of monkshood; an *extract* from the bruised *leaves*, and a *tincture* from the coarsely powdered *root.* The dose of the extract is from one to two grains, and that of the tincture from three to five drops.

The leaves, seeds, and root of the Aconitum napellus are easily identified.

The *leaves* are completely divided to the base into five wedge-shaped lobes, which are again divided into three, the segments being linear. They are not liable to be mistaken for the leaves of any other plant.

The *seeds* are numerous, three-sided, irregularly twisted, and wrinkled, of a black or dark-brown colour, about a sixth of an inch long, and weighing 25 to the grain. Fig. 67 shows their size and shape, and fig. 68 the markings on their surface, as seen under the microscope. A single seed contains enough of the active principle of the plant to produce numbness and tingling of the lips, tongue, and throat.

Fig. 67.

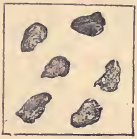


Fig. 68.

The *root* requires to be more minutely described, since it has, on more than one occasion, been scraped and eaten instead of the horse-radish. This accident occurred in 1836 to a Mr. and Mrs. Prescott and their child, whose cases are minutely described by Dr. Pereira; in 1842 to a lady residing at Lambeth (Taylor); so lately as the winter of 1853 to two brothers, of whom one died and the other recovered. Still more recently, in the winter of 1856, the poison proved fatal to two priests at Dingwall, and to a third person out of five who were affected at a dinner there. In the next year, 1857, a case occurred in London. Besides these accidental cases, the root has been given intentionally in one instance at least.

It is not easy to understand how the root of monkshood should have been mistaken for that of the horse-radish, even though the respective plants were not attached to the roots to render the mistake impossible; and though the section of both roots is white when fresh, the scrapings of the two roots are distinguishable, the monkshood being friable and succulent, the horse-radish tough and stringy, and the first soon acquire a pink colour while the second retain their whiteness. The monkshood-root differs from that of the horse-radish in shape, in colour, and in taste. The root of monkshood is conical, and throws off a large number of curling fibres, and it is not unusual to find one or more pear-shaped tubers, attached by narrow necks to the upper part of the root-stock, as in the specimens shown in the three figures annexed, which, with the single root in fig. 70, were selected out of a large number of freshly-dug roots of Aconitum napellus, as pre-

Fig. 69.

Fig. 70.

Fig 71.

senting the most characteristic varieties of form. The figures are of the size of the roots themselves. On the other hand, the root, or, as it is commonly called, the stick of the horse-radish (fig. 71) is cylindrical in all its larger branches, and throws off straight rootlets. The colour of the monkshood-root is a dark nut-brown externally, that of the horse-radish is buff-coloured. The root of the monkshood when chewed causes a peculiar tingling and numbing sensation in the lips, with a feeling of enlargement, and a similar sensation in the throat, when swallowed; and this sensation in the lips and throat continues for several hours: the taste of the horse-radish is pungent and sweet; causing profuse lacrymation, but not being very persistent.

This peculiar property which the root of the monkshood possesses, of causing numbness and tingling of the lips, is shared by the other parts of the plant, such as the leaves and seeds.

Experiments on Animals.—Experiments on animals have been made with monkshood, and its active principle aconitina, by Sir B. Brodie, Orfila, Christison, and Pereira, and more recently by Drs. Fleming and Headland. According to Dr. Fleming, aconite, when introduced into the system of one of the lower animals, causes, successively, weakness of the limbs and staggering; accelerated, or slow and labouring respiration; paralysis; diminution or total loss of sensibility of the surface; dimness of vision, or actual blindness; increasing difficulty of breathing; and, after a few spasmodic twitches, death by *asphyxia*. On examining the body immediately after death, the heart is found beating with considerable strength, which it continues to do for some time; the peristaltic action of the intestines also continues; the irritability of the voluntary muscles is impaired but not extinguished; there is general venous congestion, with distension of the right side of the heart and large veins, and venous blood is usually found in the left cavities of the heart, and in the aorta. The venous system of the brain is often gorged with blood. Dr. Fleming adds that in some of his experiments there were decided convulsive movements, and, in two instances, distinct opisthotonos; that in general the pupil was more or less *contracted*;* that the pulse became weaker and less frequent; and that the poison did not appear to give rise to any local irritation. From other experiments of Dr. Fleming's it would appear that aconite proves poisonous to vegetables.

From Dr. Fleming's experiments, then, it would seem that aconite occasions muscular debility or actual paralysis, extending from the muscles of the extremities to those of the chest; that it acts as a sedative to the heart; that it impairs or destroys common sensibility; and that it proves fatal by inducing *asphyxia*. Asphyxia, however, is not the only mode of death in poisoning by monkshood; for Dr. Fleming distinctly recognizes three possible modes of death. 1. It may prove

* This statement is opposed to Dr. Headland's experience. He found that it caused in animals dilatation of the pupil, but in a less degree than belladonna. ('Lancet,' March 29, 1856.)

fatal by a *powerfully sedative impression on the nervous system*, death taking place in a *few seconds;* 2. It may prove fatal by *suspension of the respiratory function;* and 3. It may prove fatal by *syncope*. *Shock*, *asphyxia*, and *syncope*, then, are the three modes of death in animals poisoned by aconite. In the human subject, according to Dr. Fleming, syncope is the common cause of death.

The *symptoms* of poisoning by monkshood in the human subject are:—numbness, tingling, and burning heat in the mouth, throat, and stomach, followed by nausea and vomiting, with pain and tenderness of the epigastrium. The numbness and tingling speedily become general, with diminished sensibility of the surface, vertigo, dimness of vision, or complete blindness, tinnitus aurium, and occasionally deafness; frothing at the mouth; sense of constriction in the throat, with sensations of weight and enlargement of various parts of the body, but especially of the face and ears; great muscular feebleness, with general trembling; more or less difficulty of breathing, and speechlessness; a distressing sense of sinking at the pit of the stomach, and dread of approaching death. The pulse becomes small, feeble, irregular, and finally imperceptible both at the wrist and heart; the extremities, and afterwards the whole body, become cold, and a clammy sweat bedews the surface; finally, the countenance grows blanched, the lips bloodless, and with a few hurried gasps the individual expires. He usually retains perfect possession of his mental faculties till the last, and exhibits no tendency to sleep; or there may be slight wandering delirium. The fatal result is often sudden.

Post-mortem Appearances.—These are general venous congestion, and, in some cases, engorgement of the brain and its membranes, with considerable sub-arachnoid effusion; also occasionally signs of gastro-intestinal irritation.

Commencement of Symptoms.—The symptoms of poisoning may commence in a few minutes, or not for one or two hours.

Fatal Period.—The preparations of aconite may destroy life in as little as an hour and a quarter. The extreme limit of survivorship appears to be twenty hours. The average is less than four hours, and the majority of deaths occur within three hours.

Fatal Dose.—Of the root, it is believed that less than a drachm has proved fatal; of the alcoholic extract, four grains; of the tincture, a drachm. But very severe symptoms have been produced by much smaller quantities. Dr. Headland thinks that so little as a tenth of a grain of the alkaloid *aconitina* would destroy an adult male; and Dr. Herapath performed an analysis in a case at Bristol, from which he inferred that $\frac{1}{20}$th of a grain had proved fatal.

Treatment.—There is no antidote to this poison, unless animal charcoal, recommended by Dr. Headland, is to be considered in that light. The treatment will therefore consist in the prompt administration of an emetic, followed, after an interval of time, by a full dose of castor-oil. The remote effects of the poison must be met by stimulants, such as

hot brandy and water, and ammonia. Strong coffee may also be given with advantage. Dr. Fleming also recommends friction along the course of the spine, and on the extremities, with warm cloths and spirituous liniments, and sinapisms, or bottles of hot water to the præcordia and extremities. Convulsions, should they come on, are to be treated by opening the jugular vein; and great dyspnœa, and extreme feebleness of the heart's action, by artificial respiration, and slight galvanic shocks passed through the heart.

Diagnosis.—In some instances we are able to identify some portions of the plant itself in the contents of the alimentary canal. An alcoholic extract of the contents of the stomach may be tested by the taste. The numbness and tingling of the lips would serve to prove the presence of aconite. Dr. Headland suggests that we should administer to some of the smaller animals an alcoholic extract of the contents of the stomach previously reduced by evaporation.

ACONITINA (*aconitine*).—This alkaloid is so active a poison that, according to Dr. Headland's experiments, $\frac{1}{300}$ grain will kill a mouse; $\frac{1}{100}$, a small bird in a few minutes, and $\frac{1}{50}$ almost instantaneously; $\frac{1}{20}$ of a grain a cat, and $\frac{1}{10}$ of a grain the same animal in twenty minutes or half an hour. Dr. Headland is of opinion that $\frac{1}{10}$ of a grain would prove fatal to an adult man. This estimate appears to be borne out by Dr. Herapath's case. $\frac{1}{1000}$ grain causes tingling and numbness of the tip of the tongue, and $\frac{1}{100}$ of a grain dissolved in spirit, and rubbed into the skin, causes loss of feeling, lasting for some time. Aconitina may be separated from organic liquids by the method of Stas (p. 505), or by a similar method suggested by Dr. Headland. In the fresh root, the alkaloid is contained in the proportion of a quarter to three quarters of a grain in the ounce, and in the dried root, of twelve to thirty-six grains to the pound.

Properties.—Aconitina may be obtained in a crystalline form, but generally it is seen as a white powder. It is sparingly soluble in water, but soluble in alcohol and æther, and in acids. Its salts are not crystalline. It has an acrid taste, and strong alkaline reaction. It resembles the other alkaloids in melting and depositing carbon when heated by the spirit-lamp, and in being precipitated by the solution of iodine in iodide of potassium, and by tannin.

Tests.—*a.* Strong sulphuric acid dissolves it without change of colour, but when heated, it assumes a deep brown tint. *b.* A solution of bichromate of potash added to the acid solution colours it yellow. *c.* A solution of the permanganate of potash added to the same solution is bleached. *d.* Nitric acid dissolves it, without change of colour. *e.* The terchloride of gold gives a yellowish-white precipitate. *f.* The bichloride of platinum yields no precipitate.

2. DIGITALIS (*Digitalis purpurea—Foxglove, purple foxglove*).

This is an indigenous plant, commonly met with about banks and hedge-rows, and in pastures, on a gravelly or sandy soil. It is also

cultivated in gardens, and is easily recognized by its purple dotted flowers.

It belongs to the Linnæan class and order *Didynamia angiospermia*, and natural order *Scrophulariaceæ*, or figworts.

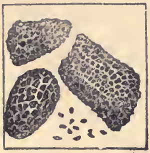
All the parts of the plant are believed to be poisonous, and the leaves have more than once destroyed life.

The plant owes its poisonous property to the alkaloid *digitalia*, which exists in the fresh leaves in the proportion of less than one per cent. The leaves of the foxglove are officinal in the London Pharmacopœia. The dried leaves powdered are given in doses of from one to three grains; an infusion made from the dried leaves is given in doses of from ℥ss. to ℥i.; and a tincture, also prepared from the dried leaves, in doses of from ten drops to half a drachm, cautiously increased.

The *root* of the foxglove consists of numerous long and slender fibres, and is not, therefore, likely to be confounded with any of the common edible roots.

The *leaves* are ovate, narrowed at the base, crenate, rugous, and veined, downy, especially on the under surface. The dried leaves have a dull green colour, a faint odour, and a bitter, nauseous taste.

Fig. 72.



The *seeds* are of the small size shown in fig. 72, and weigh about 1,126 to a grain. They are of a light brown colour, cylindrical, ovoid or conical in shape, and when viewed by the lens or microscope, present the pitted appearance shown in the figure. They may be mistaken for the seeds of the Lobelia inflata, which they resemble in colour and size. They are, however, larger.

Experiments on Animals.—In moderate doses digitalis causes vomiting, giddiness, languor, and death in twenty-four hours. In larger doses, in addition to these symptoms, tremors, convulsions, stupor, and coma. Injected into the veins, it destroys life in a few seconds, by acting on the heart and on the pulmonary circulation. In one of Mr. Blake's experiments, an infusion of three drachms of the leaves injected into the jugular vein arrested the action of the heart in five seconds, that organ after death being motionless, turgid, inirritable, and its left cavities full of florid blood.

Symptoms.—In the human subject, a single fatal dose of the poison produces the following symptoms:—Vomiting, purging, and severe colicky pains in the abdomen; pain in the head, giddiness, and dimness of vision, or actual blindness; a dilated and insensible pupil; a slow, weak, and irregular, or intermittent pulse; nausea and faintness, with occasional syncope; the skin is covered with a cold perspiration; the patient is much worse when he assumes the upright posture. Salivation is a common occurrence. The urine is suppressed; convulsions occasionally occur; and the patient sometimes continues for a considerable space of time in a state of stupor. In two fatal cases death took

place in twenty-two hours. When the poison does not prove fatal, the recovery occupies several days, and the circulation is slowly restored to its usual state.

The *post-mortem appearances* in cases of poisoning by foxglove are turgescence of the vessels of the brain, and redness of the inner membrane of the stomach.

In consequence of the frequent use of digitalis in the form of infusion or tincture in the practice of medicine, and in consequence, also, of its tendency to accumulate in the system, cases are of frequent occurrence in which serious symptoms show themselves, without terminating fatally. These symptoms are dryness in the throat, and thirst; nausea; headache; salivation; giddiness, and dimness of sight, an appearance of sparks before the eyes, and a feeling of pressure on the eyeballs; with weakness of the limbs, and a weak and rapid pulse.

The symptoms arising from the gradual accumulation of the poison in the system are nausea, dryness of the mouth, loss of appetite, and vomiting, and intense thirst; giddiness, and throbbing of the temples; restlessness and sleeplessness; a hot and moist skin; great languor and depression, with, in most cases, a slow pulse. Sometimes there is diarrhœa, sometimes salivation; and an increased flow of urine, delirium, spectral illusions, convulsions, and coma, are among the occasional symptoms.

Fatal Dose.—This has not been accurately ascertained. No poison in common use is more uncertain in its operation; and in the treatment of inflammatory diseases, as well as in delirium tremens, it is often administered in doses which would have been very unsafe in a state of health.

Dr. Pereira cites several cases of disease, both in children and adults, in which the tincture of digitalis was administered in such doses as twenty drops three times a day to an infant, and from ℥ss. to ℥i to an adult; but in the cases referred to by him, the natural operation of the poison on the healthy subject was counteracted by disease accompanied by decided febrile action, or by a state of intoxication attended by great excitement of the circulation. It is also possible that the tincture may not have been, in all these cases, of the best quality.

The *treatment* of poisoning by digitalis will consist in the use of emetics, followed by aperients, and by the free use of vegetable infusions containing tannin, such as infusion of nutgalls, or of oak-bark. Substances containing tannin are given with a view of rendering the alkaloid *digitalia* inert. Green tea or strong coffee may also be given with advantage. Stimulants, such as ammonia, wine, and brandy, should also be administered, and the recumbent posture should be strictly preserved. Friction to the spine, though less indicated than in poisoning by aconite, or when asphyxia is imminent, might be used with advantage; and, in desperate cases, artificial respiration, and galvanic shocks through the heart.

DIGITALIA (*digitaline*).—*Properties.*—When pure, this alkaloid is

a white amorphous substance; when less pure, of a light yellow or brown colour. It is sparingly soluble in cold or hot water, and has an intensely bitter taste. With acids it does not form crystallizable salts.

Tests.—*a.* Sulphuric acid dissolves it, and gives it a deep brown tint, passing to a rich puce colour when heated. After further exposure, it assumes a crimson hue. *b.* On the addition of a solution of bichromate of potash to the recent solution in sulphuric acid, the liquid becomes first yellow, then green. *c.* A solution of the permanganate of potash added to the solution in sulphuric acid is bleached. *d.* Nitric and hydrochloric acids dissolve it without change of colour. These reactions were obtained with a specimen of the alkaloid supplied by Mr. Morson. They differ from those given by Dr. Taylor, on the authority of M. Homolle ('On Poisons,' p. 835).

The quantity of the alkaloid in the leaves of the plant is less than one per cent.; and it is believed that a dose of more than one-sixteenth of a grain would produce symptoms of poisoning in the adult.

3. Tobacco (*Nicotiana tabacum*).

The Nicotiana tabacum, or Virginian tobacco, is a plant which belongs, as do so many of our chief poisons—hyoscyamus, belladonna, stramonium, and dulcamara—to the artificial class and order Pentandria monogynia, and natural order, Solaneæ or Solanaceæ.

Tobacco contains, as the source of its activity, an alkaloid, which, like that contained in conium, is a liquid; and a concrete volatile oil, known as tobacco-camphor. These active ingredients are obtainable from all parts of the plant, and are contained in the infusion and decoction, and in the smoke, blended with carbonate and acetate of ammonia, and several gases.

Experiments on Animals.—The effects produced by tobacco on carnivorous animals (for the herbivora are less affected, and differently) are: nausea, vomiting, sometimes purging, universal tremors, staggering, convulsions, and stupor. In the experiments of Orfila, ℥vss. of rappee introduced into a dog's stomach, the gullet being afterwards tied, killed the animal in nine hours; and ℥ii applied to a wound killed another animal in an hour.

Infusion of tobacco, as appears from the experiments of Sir Benjamin Brodie, paralyses the heart, acting, as other experiments prove, through the nervous system; but the empyreumatic oil of tobacco does not cause paralysis of the heart, as Sir Benjamin Brodie proved by placing a single drop of it on the tongue of a cat. It caused convulsions and death in two minutes. On opening the body, the heart was found beating with regularity and force.

Symptoms.—The effects of tobacco on the human subject are similar to those which it produces in animals. The first symptoms are

acceleration and strengthening of the pulse, with very transient excitement, sudden giddiness, fainting, and great sickness, accompanied with a weak, quivering pulse. These effects are, for the most part, transient, but occasionally they are more serious, and may even prove fatal. Dr. Marshall Hall relates the case of a young man who smoked two pipes for his first debauch, and was seized, in consequence, with nausea, vomiting, and syncope, then with stupor and stertorous breathing, general spasms, and insensible pupil. Next day the tendency to faint continued, and in the evening the stupor, stertor, and spasms returned, but from that time he recovered steadily. Other authors have reported cases of death from excessive smoking. Fatal results also sometimes follow the use of tobacco infusion or tobacco smoke introduced into the bowels. Severe effects have also followed from the abuse of snuff, from external application of tobacco, and from sleeping surrounded by bales of the weed.

Commencement of Symptoms.—The symptoms may show themselves in a few minutes.

Fatal Period.—Eighteen minutes is the shortest fatal period.

Fatal Dose.—Half a drachm (Copland).

Post-mortem Appearances.—These are not very characteristic. Turgescence of the vessels of the brain, and marks of inflammation in the stomach have been found.

Treatment.—If the tobacco has been taken in substance, and it has not been discharged by spontaneous vomiting, emetics must be first administered. The after treatment must consist of the free use of stimulants.

NICOTINA (*Nicotia*).—This alkaloid has acted fatally as a poison in two instances: one in Belgium in 1851, when it was administered by Count Bocarmé to his brother-in-law, the other in London in 1858, the act being suicidal. The alkaloid acts with the rapidity, and somewhat after the manner of prussic acid. Dr. Taylor found that a single drop killed a rabbit in three minutes and a half, with tetanic convulsions. The victim of Count Bocarmé does not seem to have survived five minutes; and in the suicidal case death was quite as rapid. The patient was observed to stare wildly, and to die without convulsions, while heaving a deep sigh.

The *post-mortem appearances* in this case were general relaxation of the muscular system, staring eyes, bloated and livid features, the vessels of the scalp and membranes of the brain, and those of the lungs, gorged with black blood, and the cavities of the heart, with the exception of the left auricle, empty. There was intense congestion of the mucous membrane of the stomach, and of the liver. The blood was black and liquid, and, in some parts, had the consistence of treacle. Dr. Taylor detected nicotina in the stomach, liver, and lungs, by a process similar to that of Stas. (See Taylor, 'On Poisons,' p. 750.)

Properties.—Nicotina resembles conia in being a liquid and volatile

alkaloid. When quite pure, it is a colourless oily liquid, but becomes of an amber colour on exposure to the air, and deepens in tint by keeping. A drop placed on a white surface of enamelled glass has a green colour, while conia is pink; and the same difference of colour obtains if the liquids are dropped on filtering paper, when they produce a greasy stain. It has an acrid taste, but a pleasant æthereal odour; while conia has a disagreeable odour, which might be mistaken for that of stale tobacco. Otto thus describes the odour of nicotina, and his description is true of two specimens in my possession; but Dr. Taylor states that a specimen which he examined evolved the odour here described as belonging to conia. Nicotina is soluble in water, in alcohol, and in æther; and the aqueous solution has a decided alkaline reaction. With acids, the alkaloid forms fixed salts, and with several reagents characteristic crystallizable compounds.

Tests.—a. Nicotina resembles conia and the fixed alkaloids in the effect of heat, and in the precipitates which it yields with the solution of iodine in iodine of potassium, and with tannic acid. *b.* Sulphuric acid combines with it without change of colour, and the mixture gives a yellow tinge to a solution of the bichromate of potash, and a pale green to that of the ferridcyanide of potassium. *c.* Nitric acid also does not change the colour of the alkaloid. *d.* Terchloride of gold yields an abundant amorphous yellow precipitate. *e.* Bichloride of platinum yields a yellow crystalline precipitate. *f.* Bichromate of potash gives a yellow crystalline precipitate. *g.* Ferridcyanide of potassium yields a yellow crystalline precipitate. *h.* Corrosive sublimate throws down a white deposit, which is found to consist of well-defined groups of transparent plates attached to a darker centre in the form of flowers, winged insects, and bows of ribbon. *i.* Oxalic acid gives with the alkaloid crystals of oxalate of nicotina.

In some of these reactions nicotina resembles ammonia. It is sufficiently distinguished from it by the fact, that ammonia reddens tannic acid, and gives with the solution of iodine in iodide of potassium a dark-green precipitate.

4. Lobelia (*Lobelia Inflata. Indian Tobacco. Bladder-podded Lobelia*).

Lobelia inflata belongs to the artificial class and order, *Pentandria Monogynia,* and natural order *Lobeliaceæ.* It is a native of North America, and has long been used by the aborigines: it at length became a quack medicine among the American irregular practitioners, was the subject of favourable notice by a clergyman (Dr. Cutler) and of a work by an English physician, Dr. Reece, in the year 1829, in which work it was highly commended as an *anti-asthmatic.*

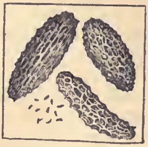
The herb is usually imported into England by the Shaking Quakers of New Lebanon, North America, compressed into oblong cakes weighing half a pound or a pound each, wrapped in blue paper (Pereira).

The seeds, and the powder of the seeds, are sold by all the herbalists. Both have proved fatal in several instances in America and in England.

The dried herb is of a pale green colour; it has a nauseous odour, and a burning and acrid taste, closely resembling the taste of tobacco. The taste and odour are believed to be due to a volatile oil, to a resinous alkaloid (lobelin), and to a peculiar acid.

The seeds of lobelia are brown grains of the small size shown in fig. 73, and weigh 3176 to a grain. They have the shape and microscopic characters depicted in fig. 73.

Fig. 73.



Lobelia is an active medicine, and a potent poison. In ten grain or scruple doses of the powdered leaves or seeds it is a strong nauseating *emetic*; and has, indeed, been termed the *emetic weed*. A tea-spoonful or a drachm is sufficient to destroy life.

The symptoms occasioned by the lobelia are speedy vomiting followed by distressing nausea, with headache, giddiness, and tremors, copious sweats, and extreme depression. Diarrhœa is sometimes present, and some degree of dysuria is occasionally experienced. Sometimes the pulse intermits, as a consequence of its depressant effect on the circulation. The fatal event is ushered in by convulsions. Employed as an enema it acts as tobacco does, causing the same sickness and tendency to faint.

Fatal Dose.—A case of poisoning by ʒi of the powdered leaves occurred in England in 1847.

Fatal Period.—In this case death happened in about thirty-six hours.

Post-mortem Appearances.—The mucous membrane of the stomach is found intensely inflamed, and the vessels of the brain strongly congested.

The *treatment* of poisoning by lobelia will consist in promoting vomiting by draughts of warm water, and tickling the throat, following this up by the free use of stimulants to counteract the depressing effect of the poison. As its effects so closely resemble those of tobacco, it will require the same treatment.

5. Conium (*Conium maculatum—Hemlock. Common or spotted Hemlock*).

This plant grows abundantly in our hedge-rows all over England. It belongs to the natural order Umbelliferæ or parsley tribe, to which tribe also belong the Æthusa cynapium, or fool's parsley, the Cicuta virosa, or water hemlock, the Œnanthe crocata, or water dropwort, and the Œnanthe phellandrium, or fine-leaved water dropwort—all poisonous plants.

The plant is readily recognized by its tall, smooth, glossy green

stems, dotted with brownish-purple spots. Its root is tapering, like that of the parsnep, and its leaves have been often mistaken for those

Fig. 74.

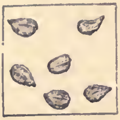


Fig. 75.

of parsley. The seeds are of the size and shape shown in fig. 74. They weigh about 20 to a grain, and under the lens have the ribbed appearance shown in fig. 75. They are distinguished from other seeds of the umbelliferæ by the presence of five prominent wavy ridges (fig. 75), and the absence of the linear receptacles for volatile oil termed *vittæ*. Every part of the plant has a strong unpleasant odour by which it is readily recognized. This odour is strongly developed when the plant is rubbed with liq. potassæ. The odour has been compared to that of mice. The active volatile liquid alkaloid *conia* on which its poisonous properties depend, has the same mousy odour.

The part of the plant usually taken as a poison is the leaves. The effects which they produce are not always the same; for in some instances they seem to have produced narcotic symptoms, preceded by intoxication; in others paralysis of the muscles extending to those of respiration, and causing death by apnœa.

Symptoms.—Dryness and constriction of the throat, headache, drowsiness, dilated pupil, loss of power in the extremities, passing into perfect paralysis; inability to swallow; pulse small and quick, or slow and intermitting, and the respiration embarrassed. Death takes place from gradual loss of power in the respiratory muscles. Delirium, coma, and convulsions are occasional symptoms. The pupil is described as dilated and fixed.

The post-mortem appearances are those proper to apnœa, with redness of the mucous membrane of the stomach, and congestion of the vessels of the brain.

Treatment.—After emptying the stomach by emetics, a full dose of castor oil to remove the poison from the bowels; followed by the treatment proper to apnœa, including the free use of diffusible stimulants.

Commencement of Symptoms.—From a few minutes to a quarter of an hour.

Fatal Period.—One hour in a child; three hours in an adult.

Fatal Dose.—The smallest quantity that may prove fatal is not ascertained.

Conia (*Conein, conicin, conicina*).—This alkaloid destroys life in the same way—by producing apnœa. It does not seem to paralyze

the heart; but affects the whole system of voluntary muscles, in common with the muscles of respiration. In some experiments on animals *conia* has been found to give rise to tetanic spasms. The pupils were stated to be *dilated* and insensible.

From experiments on animals it appears that this alkaloid, in doses of one or two drops, may kill a rabbit, cat, or dog in the short space of five minutes.

Properties.—Conia, like nicotina, is, when pure, an oily, volatile, colourless liquid; but it turns yellow and grows darker by exposure. Placed on a white surface of enamelled glass it has a pink colour, and it gives the same colour to filtering paper, on which it leaves a greasy stain. It has an acrid taste, and disagreeable pungent odour of the plant itself. The odour may be compared to that of mice, or of stale tobacco. It is less soluble in water than nicotina, but readily dissolves in alcohol and æther. The aqueous solution has a strong alkaline reaction. With acids it forms salts. It forms thick white fumes with the vapours of nitric, hydrochloric, and acetic acids. In common with the alkaloids, it deposits carbon when heated, and yields a yellowish-brown precipitate with the solution of iodine in iodide of potassium, and a white precipitate with tannic acid.

Tests.—a. Sulphuric acid does not change its colour, and the acid mixture is tinged pale yellow by a solution of the bichromate of potash, and by the solution of ferridcyanide of potassium. *b.* Nitric acid deepens its colour, and gives out with it dense white fumes. *c.* Chloride of gold gives a yellowish-white precipitate. *d.* Bichloride of platinum does not precipitate it. *e.* Corrosive sublimate gives a white amorphous precipitate. *f.* Oxalic acid forms with it an oxalate of conia, which is deposited as crystals.

CHAPTER XXI.

1. Ergot of Rye.
2. Cicuta virosa.
3. Phellandrium aquaticum.
4. Æthusa cynapium.
5. Cytisus Laburnum.
6. Solanum nigrum.

1. Ergot of Rye (*Spurred Rye. Secale cornutum*).

This substance is the result of a disease attacking the grain of several plants, such as wheat, barley, oats, and rye, in wet seasons, and in ill-drained soils. The ear of the plant is occupied wholly, or in part, by the diseased grains, each of which is of a deep purple colour, elongated, slightly curved, and projecting, so as to bear some resemblance to a cock's spur. These diseased grains, collected, dried, and powdered, form the ergot of the shops, used by the accoucheur to promote contraction of the uterus, and sometimes criminally administered to procure abortion.

Properties.—The ergot, in its entire state, varies in length from a quarter of an inch to two inches, and in thickness from a sixth to a third of an inch. Its surface is black, with lighter dotted streaks, and its substance reddish-grey. It is lighter than water, has a disagreeable odour, and somewhat acrid taste.

Tests.—*a.* Liq. potassæ gives it a lake-red tint, and develops the characteristic odour. *b.* The filtered alkaline liquid has the same colour, and lets fall the same coloured precipitate, on the addition of nitric acid, or a solution of alum in excess.

Experiments on Animals.—The symptoms produced in animals by large single doses of the ergot, or by smaller doses frequently repeated, are partly those of intestinal irritation, partly those indicative of affection of the nervous centres. To the first belong diarrhœa, to the last, giddiness, dilated pupil, drowsiness, and paralysis. Suppurating tumours, and gangrene of the extremities, are also among the symptoms.

In the human subject a single full dose gives rise to irritation of the stomach and bowels, giddiness, headache, and flushing of the face, with great lassitude and weariness.

When the spurred rye, or other grain similarly diseased, is mixed with flour and made into bread it gives rise to an epidemic malady

which assumes the form either of *ccnvulsive* or of *gangrenous ergotism.* In the first form nervous symptoms, such as giddiness, weakness of the limbs, mental incapacity, coma, and convulsions predominate ; in the latter, dry gangrene of the extremities.

The symptoms produced by spurred rye, or by other grain similarly diseased, present such a combination of intestinal irritation and nervous affections as to justify the assigning it a place among the narcotico-acrid poisons.

2. Cicuta virosa (*Water Hemlock. Cowbane*).

This is a perennial, indigenous, umbelliferous plant, growing in wet ditches and on the banks of streams. It attains three or four feet in height, has a stunted stem, and large dark-green tripartite leaves. The leaflets are grouped in twos or threes, narrowly spear-shaped and serrated ; and the leaf-stalks are of a reddish colour where attached to the stem. The root stalk, which has been repeatedly mistaken for parsneps, is hollow and filled with large cells.

In *animals* the root gives rise to tetanus. In *man* well-marked tetanic spasms are also among the prominent symptoms, together with dilated pupil, insensibility, and coma, nausea, vomiting, and diarrhœa. Death may take place within an hour of the swallowing of the poison.

3. Phellandrium aquaticum (*Fine-leaved Water Hemlock*).

This, too, is an indigenous, umbelliferous plant, growing in similar situations with the foregoing, and of which the tapering root eaten by mistake for parsneps has produced poisonous effects. The plant grows to about three feet in height, and is furnished with small finely-divided dark-green leaves.

4. Æthusa cynapium (*Fool's Parsley*).

The leaves of this plant, as its name implies, have been eaten by mistake for parsley. The roots also have been eaten by mistake for young turnips. It is an annual umbelliferous plant, growing in gardens and fields, and may be recognized by the secondary involucres appended to the flower-stalks, which are composed of three long and narrow drooping leaflets (bracts). When rubbed, the leaves have a nauseous odour. When given to *animals* it occasions convulsions and stupor. The symptoms in *man* are heat in the mouth and throat, nausea and vomiting; with headache, giddiness, stupor, dilated pupil, convulsions, and locked jaw.

5. Cytisus Laburnum (*Laburnum*).

Every part of this common plant appears to be poisonous, and cases are recorded of poisoning by the seeds, flowers, and bark. All

parts of the plant have an extremely nauseous and disagreeable odour and taste. It owes its poisonous properties to an alkaloid known as *Cytisin*. From Christison's experiments with the dried bark, it follows that the laburnum is an extremely active narcotico-acrid poison, producing, in the space of a few minutes, violent tetanic convulsions, and speedy death. In *man*, the symptoms are those of violent irritation of the alimentary canal, with great exhaustion, drowsiness, and rigidity of the limbs, convulsions, dilated pupil, and frequent pulse.

6. Solanum nigrum (*Common Nightshade*).

The black berries of this plant have been eaten by mistake, and have given rise to mixed symptoms of intestinal irritation—nausea, vomiting, colic, and intense thirst; and cerebral affection, dilated pupil, stertor, and tetanic convulsions.

The red berries of the Solanum dulcamara, woody-nightshade, or bitter-sweet, produce similar symptoms; but they do not appear to be a very active poison.

Solania (*Solanine*).—This is the active principle of the S. nigrum and dulcamara.

Properties.—Solania is obtained as a white powder, soluble in water, in acids, and in alcohol.

Tests.—*a.* Concentrated sulphuric acid gives it a deep yellow tint, which deepens to a red-brown when warmed, and becomes almost black when heated. *b.* Bichromate of potash, when added to the solution in sulphuric acid, imparts a faint yellow colour. *c.* Nitric acid produces no change of colour. *d.* It is not precipitated by the solution of iodine in iodide of potassium. *e.* It gives no precipitate with bichloride of platinum.

CHAPTER XXII.

1. Oil of Turpentine.
2. Oil of Tar.
3. Kreasote.
4. Oil of Dippel.

1. *Oil of Turpentine.*—Though this liquid has not yet proved fatal, it is evidently possessed of poisonous properties, partly irritant, partly narcotic. Two drachms of the oil have killed a dog in three minutes, the effects showing themselves immediately in staggering, cries, tetanus, and failure of pulse and respiration (Professor Schubarth, as cited by Christison). In the human subject it is often given as an aperient, or used as an injection, for the destruction of worms, or to promote the expulsion of flatus from the bowels. For these purposes it has been administered in doses of one, two, or three ounces, and has acted only as an aperient; but in some instances it has caused violent irritation of the urinary organs, and in others intoxication, followed by coma, collapse, and convulsions.

2. *Oil of Tar.*—This liquid gives rise to similar symptoms, and has proved fatal, in one instance, in about twenty-four hours.

3. *Kreasote.*—This is one of the products obtained from wood-tar. It is named from its property of preserving flesh, and possesses very powerful antiseptic properties: it is used in medicine, chiefly for the purpose of checking obstinate vomiting; but it is also employed as a local application to carious teeth, and externally, in a state of dilution, in fœtid ulcers, and in some skin diseases. If applied to the skin it destroys its vitality.

Kreasote is an active poison. Thirty drops suffice to kill a rabbit in one minute. In the human subject, a large medicinal dose produces irritation of the stomach and bowels, with giddiness, headache, and drowsiness. Two drachms in a single dose have proved fatal to an adult in thirty-six hours.

4. *Oil of Dippel.*—This animal oil is the product of the destructive distillation of hartshorn, bones, and other animal matters. It has twice proved fatal in the human subject, but under circumstances which have prevented a full description being given of the symptoms occasioned by it. Vomiting was present, and, on examination of the body, there were marks of irritation of the stomach and bowels, and of strong corrosive action in the mouth and gullet.

All the liquids contained in this chapter possess highly characteristic physical properties, and among others an odour which enables them to be easily recognized in the contents of the alimentary canal and throughout the body.

The treatment of cases of poisoning by them will commence with the use of the stomach-pump, or of emetics; and as kreasote possesses the property of promptly coagulating albumen, white of eggs diffused through water would form an appropriate antidote, as well as a suitable emollient application to the inflamed intestinal canal, in poisoning by kreasote as well as by the other liquids mentioned in this chapter.

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